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The La Prele Dam; A 130-Ft. Hollow Reinforced-Concrete Dam Near Douglas, Wyoming.

About 15 miles west of Douglas, Wyo., on the La Prele River, a branch of the Upper Platte, there has recently been completed a hollow reinforced-concrete dam of the Ambursen type, 130 ft. high, the largest of this design which has thus far been built. The structure is a portion of a private irrigation project which involves some 20 miles of canals fed by a 25,000 acre-ft. reservoir formed by the storage of the waters of the La Prele River behind the dam. Except in size the structure does not differ greatly from others of the same type, but the massiveness of it, and the fact that it was built some 15 miles from the nearest railway or other base of supplies, make it worth noting.

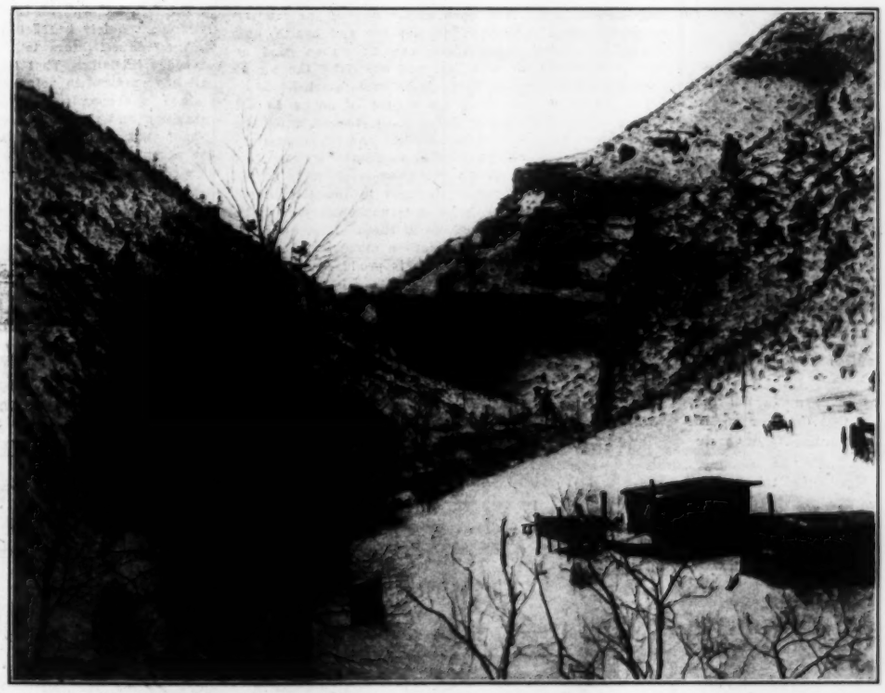

FIG. 1. VIEW UP THE CANYON TOWARD THE LA PRELE DAM, WYOMING.

The principal feature in which this dam differs from all others is that while the greater portion of the dam rests upon the solid rock of the mountain, the middle 80 ft. which is subjected to the greatest head and pressure is on a hardpan or shale. The problem, therefore, was to secure absolute continuity of foundation so as to avoid any chance of settlement. Work was commenced in the spring of 1908, but owing to the unfavorable financial condition of the country, the work was greatly hampered in its progress so that about a year and a half was consumed in its completion, whereas under ordinary circumstances it would have been built in ten months. It was completed late in 1909 and the Spring floods of the following year very nearly filled the reservoir.

The dam site is in a narrow canyon (Fig. 1) of the river, where the rugged sandstone cliffs almost come together to form an ideal location for such a structure. The stream itself has a small low-water flow, so little in fact that it did not interfere to any great extent with the foundation operations. Under the stream and across the valley bottom there is a 10 to 15 ft. surface of so-called "slide" composed of boulders, broken stone and gravel, overlying a sandstone in broken strata and, below that, a hard red shale. On the sides of the gorge (Fig. 6) the sandstone protrudes. This provided a good base, both on the sides and on the bottom for the construction of the footings of the dam.

As shown in Figs. 2-3, the dam is of the usual hollow, buttressed type with a floor and a cut-off wall. It is about 330 ft. wide at the top and tapering down to about 110 ft. at its base. Five bays at one side are provided with a spillway, normally at an elevation of 125 ft. above the floor, but the remainder of the crest is at an elevation of 130 ft. above the floor. This spillway is provided with stop logs which, on occasion, raise the water level to that of the main crest line (Fig. 3). Across the top of the dam there is an 8 ft. 6 in. roadway, guarded by parapets, providing a passageway from one side of the gorge to the other.

The details of the design are shown on Fig. 3. In cross-section the dam is faced with a deck on the up-stream slope, about 40° to the horizontal, which deck is held up by a series of heavy buttresses, spaced 18 ft. c. to c., and footing on a heavy floor which extends over the entire base. The "shale" layer, described above, is fairly hard and can be picked out only with difficulty, so upon it the plain concrete floor was laid, going down at all places at least 3½ ft. At the heel of the dam a 6-ft. cut-off wall was sunk down into the hard red shale, a distance varying from 10 to 18 ft. At the toe a shallower cut-off wall was built down into the "shale" but not to the hard rock. Weep holes two feet square are provided in the floor of the dam. The angle at the foot of the slope wall is packed with puddled clay as a further precaution against underwash there.

Each buttress is footed on the floor on a spread foundation 14 ft. 6 ins. wide at the bottom and stepping up to a thickness of 4½ ins. for the first lift. Thereafter the buttresses are divided into vertical lifts of 12 ft. each, the thickness dropping off at each one as it approaches the top, where it is 12 ins. Reinforcement is provided for every alternate lift, in the form of horizontal rods variously spaced as shown in Fig. 3, but all of ⅞-in. section for the sake of uniformity. The buttresses are all tied together by horizontal beams placed at intervals through the dam at the top of the non-reinforced lifts of the buttresses. Openings were left in the buttresses for convenience in construction.

The deck varies in thickness from 54 ins. at the bottom to 12 ins. at the top, the change being made by a uniform reduction. It is reinforced with horizontal rods spaced so that 55 rods are in one lift of the slab. Every third rod is bent up at the ends to provide shear resistance, up to the second lift from the top where the slab is relatively deep enough not to require shear rods. This deck is made up of independent slabs between each pair of buttresses, according to the detail shown in Fig. 5. Each buttress extends out to the slab face and is provided, where opposite the slab, with a double-grooved tongue, into which the slab fits, the slab itself being supported on brackets cast on the sides of the buttresses. In the construction, the buttress was first built to the top of a lift, and the grooved tongue made at the

upstream face. This groove was then painted with a waterproofing consisting of successive coats of asphalt primer, waterproof paint, felt laid in asphalt and asphalt, after which the concrete slab was placed. A small V-groove was left where the top of the slab meets the top of the tongue, and this was finally filled with pitch as a last precaution against water passing the joint. The slab was stopped at the top of the lift and a horizontal joint, with a V-groove, left, for the next lift of slab to fit into. The V-groove was left for purpose of improving bond only. All surfaces were picked, scrubbed and grouted before placing new concrete.

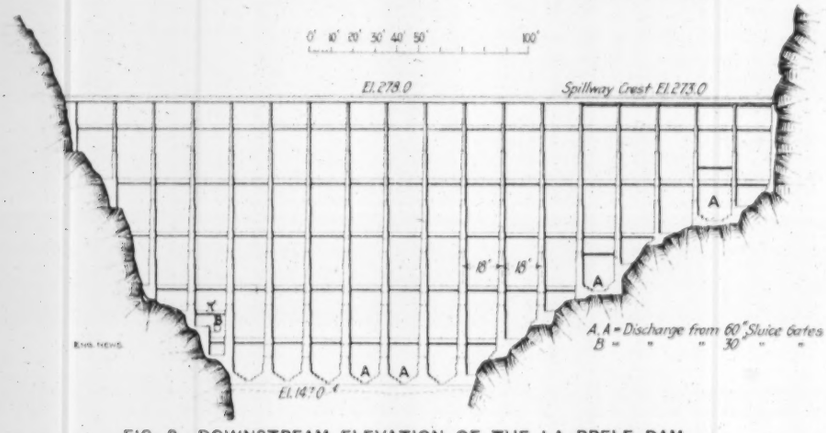

FIG. 2. DOWNSTREAM ELEVATION OF THE LA PRELE DAM.

With the exception of some minor connecting rods, all reinforcement was of ⅞-in.-square bars, variations being made in spacing to care for differences in stress. This was done on account of the remoteness of the site, which made uniformity in material a desirable feature. The ⅞-in. rods were packed into the canyon in 30-ft. lengths and bent and sorted as required. In the facing slab the size and spacing of the rods is about the same at the base as at the top, and the variation in pressure is cared for by varying the thickness of the slab. In the buttresses, however, the rod spacing increases toward the top.

Under maximum water there is a pressure of 20,000,000 lbs. striking a point 7.5 ft. outside the middle of the base of each 18 ft. buttress section at an angle of 27° 15'. This gives a maximum footing pressure of about 3.5 tons per sq. ft., which the footing is amply able to bear. Stresses in the steel do not exceed 12,000 lbs. per sq. in. and in the concrete 600 lbs. per sq. in. in compression. In shear the concrete was designed for 60 lbs. per sq. in.

To lead the water to the irrigation ditches, four 60-in. and one 30-in. conduits are provided in the locations shown in Fig. 2. These conduits are driven through the face of the dam in clear opening, wooden forms being placed during concrete laying and removed when the concrete had set. In these openings are set the gates which are operated by stems passing through stuffing boxes to geared hoists located just inside the face slab at each opening.

In the construction of the dam, the bottom flooring was first built clear across the site, by diverting the small flow of the stream from one side to the other. A sluiceway was then built about the middle of the dam (Fig. 6) and through this the waters of the river were allowed to flow during the entire construction. When the work was completed the front of the sluiceway was shut off, the water diverted through the lowest line of conduits and the temporary sluiceway filled up, according to the design.

As stated before, the site is far removed from a base of supplies, so all materials had to be carted into the gorge. A construction camp was built near the dam for the use of the men and they lived there during the entire work. Sand, cement, lumber and steel had to be brought from a distance, but stone was found near the site and was crushed on the job.

The dam was designed and built by the Amburson Hydraulic Construction Co., of Boston, Mass.

The Contamination of City Air.*

By DR. GEORGE A. SOPER,† Mem. Am. Soc. C. E.

Air, like water, is, in a natural condition, pure. It is to man's use of it that the most harmful attributes which it sometimes possesses are due. So far as the essential gases are concerned, the atmosphere of the prairies is as pure as that of the sea, and the air of the marshes is as wholesome as that of the mountains. In the open there is as much oxygen in one place as in another. Much of the difference in chemical composition which seems to exist is due to differences of temperature and humidity and the effect of various conditions acting agreeably or otherwise through the senses of sight and smell. The point most worth bearing in mind in considering this question is that under the natural conditions which exist in the free, open atmosphere of the country there is always enough oxygen for life and health, and rarely any other gases which can do either good or harm. It is the air of cities, and especially the air of inclosed spaces, that is likely to be contaminated.

The air impurities which are worthy of notice do not belong to any one class or group of substances, as do the water impurities which affect health. Aerial contamination may be chemical, physical or microbic. By chemical impurities is meant chiefly the gaseous products of industrial works, compounds produced in the combustion of coal and illuminating gas. It is unnecessary to make extended mention of the effects of these gases, although the fact should be noted that carbon monoxide, a prominent ingredient of the gas which is produced when coal and other carbonaceous matters are burned with an insufficient supply of air, is a powerful poison, which not infrequently causes death in mines and elsewhere. Methane is the greatest danger of mines. It is produced when organic matter is decomposed in the absence of air and presence of water. Sewage septic tanks give it off, for example. Methane, like carbon dioxide, destroys life by diluting the oxygen present. There must be a large proportion of it to affect one seriously. It is explosive when mixed with about ten times its volume of air.

There is no gas known to science as sewer gas, the ghost which formerly went by that name and was supposed to creep with deadly effect into dwellings through plumbing fixtures having been laid [illegible] houses and [illegible] are often present in the air of sewers, as is the more dangerous illuminating gas and gasoline vapor. These two have from time to time caused startling explosions in the sewerage systems of New York and other cities.

Turning to gaseous impurities due to the presence of human beings, it is reassuring to know that [illegible] which has passed through the lungs possesses practically no poisonous properties of chemical composition despite of the teachings to the opposite effect which are favorite theme of text-books. The unpleasant odors objectionable chiefly because they are unpleasant. Perhaps that statement should be qualified to this effect, that although every effort has been made by scientists for years to detect the presence of poisonous products of respiration, those efforts have been without success.

The air of an overcrowded and badly ventilated room is slightly lacking in oxygen, but the deficiency is generally not great and under ordinary circumstances is readily compensated for by an imperceptible acceleration in the rate of breathing. Accelerations of far greater extent than any which are likely to be produced by a deficiency of oxygen due to bad ventilation take place upon the slightest exertion in any atmosphere.

Air which has passed through the lungs is loaded with vapor and with carbon dioxide, but in view of the harmless nature of the latter gas its presence need not, under ordinary circumstances, be considered of great importance. The sanitary significance of carbon dioxide lies in the index which it affords of the presence of other and more dangerous impurities of human origin. Tests of air for carbon dioxide are like tests of water for chlorine—they furnish a clew to the presence or absence of harmful microbes.

The free atmosphere, that is, the air out of doors, possesses a sensibly beneficial quality which has baffled the keenest investigators to explain and it cannot be produced artificially. That freshness, the quality which we all have noticed in going out of doors, can never be obtained in a completely inclosed room. It is at once the ambition and the despair of ventilating experts to bring about such a condition. It seems to be impossible even to account for it.

BACTERIAL INFECTION.—The microbic poisons which air sometimes contains are by all means the most directly dangerous impurities which are likely to be present. They are the inciting cause of tuberculosis and pneumonia, which, together, produce more deaths than any other disease or group of diseases to which man is liable. The forms of sickness which are transmissible by air include nearly every contagious and infectious disease which occurs in our northern climate, except the disease which has the distinction of being named bad air, or malaria.

How disease germs get into the air, how long they survive and how they fasten their infinitesimal personalities upon their unwilling hosts, is a subject of fascinating interest, but one which we can notice here only in the briefest terms. Everything is not yet known about this subject, by any means. A few facts readily

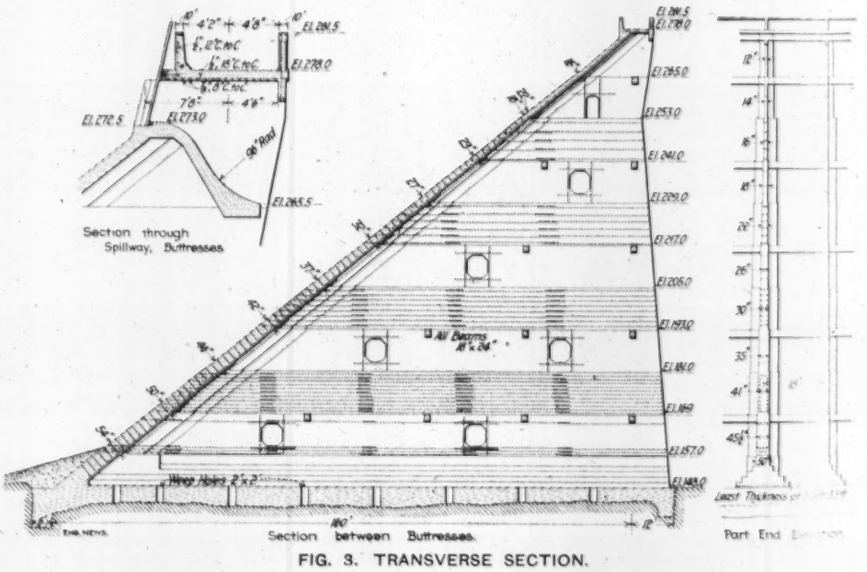

FIG. 3. TRANSVERSE SECTION.

*From a paper read before the Sanitary Section of the Boston Society of Civil Engineers, March 2, 1910. The full paper is printed in the Journal of the Association of Engineering Societies for August, 1910.

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understood, are worth keeping in mind for the sake of the simple precautions to which they point.

The sputum of persons suffering from respiratory affections contains the infectious germs of their diseases in immense numbers, and it is desirable that this material should at once be rendered inert by disinfection, preferably by burning, in order that its poisonous nature may be destroyed. In a dried state these germs may persist for weeks, although it is doubtless the fate of most of them to perish under such natural influences as desiccation and sunlight within a brief time.

FIG. 4. A NEAR VIEW OF THE DOWNSTREAM PORTION OF THE 130-FT. HOLLOW CONCRETE DAM.

It seems unnecessary to mention the fact that the sputum in tuberculosis and in pneumonia may remain capable of producing tuberculosis and pneumonia when inhaled by persons who are in a receptive condition. And yet that point has been disputed.

It is not considered, however, that tuberculosis and pneumonia are most often contracted by breathing germs which have been dried and raised from the floor or the street in the form of dust. Hygienists are coming to the opinion that the destruction of most species of pathogenic bacteria proceeds rapidly outside of the favorable environment of the body, and that the transmission of disease germs from person to person generally takes place in ways which are comparatively short and direct. This view is reasonable and reassuring and goes far to compensate for the disquieting results of some recent investigations, which show that bacteria may be projected into the air from wet surfaces and under favorable conditions of temperature and moisture retain their normal characteristics for considerable periods of time.

More important to most of us is the danger of germs thrown into the atmosphere by persons in the acts of coughing, sneezing and speaking. It has been found that in these natural and apparently innocent performances minute particles of saliva are ejected in great number, and that these droplets often contain bacteria. The moisture soon evaporates, leaving the germs free to keep afloat in air currents or gradually subside like motes of dust. Cough spray, as this fusillade of germs is called, may be highly poisonous, for not only are the bacteria which it contains thrown into the air in a perfectly fresh and virile condition, but they are relatively concentrated. Fortunate it is that so few of the countless species of bacteria which exist are capable of causing disease, yet the fact that the mouth is the normal habitat of at least a half dozen kinds of germs, and is sometimes the abiding place of diphtheria bacilli and other pathogenic species, considerably modifies the comfort which we can take in this reflection.

DUST.—Dust is directly or indirectly the greatest enemy of man. Aside from the enormous cost involved in the continuous warfare which is waged against it for the sake of mere cleanness, dust is dangerous to breathe. It is dangerous to breathe, not so much on account of the microbes which it contains, as because it is dust. Physiologists assert that nothing so predisposes the delicate structures of the nose, throat and lungs to invasion by microbes of respiratory diseases, and we can all bear testimony to the irritating and aggravating effect which a dust-laden atmosphere produces upon the sore throats and colds which most of us experience every winter.

It is probably the very commonness of the dust evil which makes us so indifferent to it, as we must frankly confess ourselves to be. We forget that it is composed of the offscourings of our bodies and the wear and tear of our clothing, habitations, shops, factories and streets, not to mention the comminuted refuse of our kitchens and the desiccated excrement of horses upon the public highways. We are too indifferent to the way in which it floats in and out of our houses and contaminates the food we eat, the water we drink and the air we breathe.

Sanitarians have given much attention to dust, and have divided it into several classes according to its harmful effects upon the human organism. In the dusty trades, so-called, the most destructive dusts are those whose composition is most unlike the soft and yielding structures of the respiratory apparatus. The grinding and polishing of metals, and the cutting of hard stone, are, because of their dust, among the most hazardous occupations in which a person can engage. "Grinders' rot" is a name popularly employed for the tuberculosis which commonly affects knife grinders before middle age. Pneumokoniosis is a longer and more scientific term by which the medical profession designates diseases of the lungs brought on by dust of whatever kind.

There are many dusty occupations, each with a startling mortality peculiar to itself. Upon investigation, the immediate cause of death is always found to be the same—tuberculosis and pneumonia. The direct cause of death is disease contracted from germs thrown off perhaps by a fellow workman; the indirect cause is a pair of lungs which have lost their normal resilience and peculiar spongy texture and have taken on a hard consistency and dull, somber hue from the dust which they have absorbed. The lungs of coal miners are black; the lungs of men and women who have lived for some years in cities are gray, and the lungs of country people are a bright, healthy red.

SMOKE.—I should say a word here with regard to the smoke evil, which the United States Geological Survey has estimated costs in one way or another as much as $600,000,000 a year to the people of the United States. Campaigns against smoke appear to have had very ancient origin. Several hundred years ago laws were passed in England to restrict the burning of very smoky coals, and to-day there are laws in effect in many English cities—Liverpool, Manchester and Sheffield, for example—which restrict the amount of smoke which may be produced from a given chimney to a fraction of the time.

One of the most ingenious ideas for the restriction of smoke seems to be American. There is a commercial firm which goes about and offers to install an anti-smoke furnace in your establishment. You pay this firm from the amount of money which you save in the consumption of coal over the ordinary method. The name of that firm was recently mentioned at the American Public Health Association convention by the celebrated expert in tuberculosis, Dr. Knopf, who strongly advocated the abolition of smoke, or at least its repression to the lowest terms, as a public health measure.

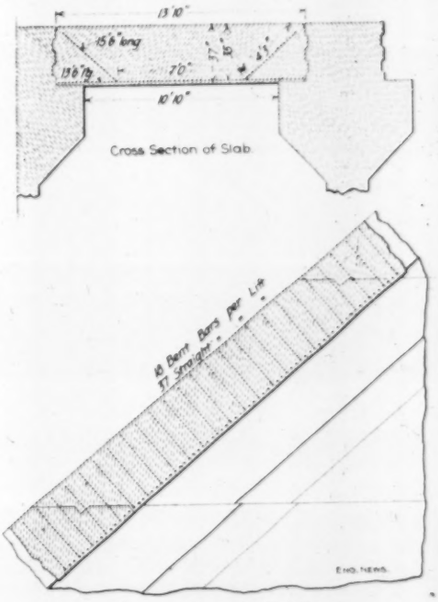


Fig. 5. Details of Slab and Buttress Connection.

THE REMEDY.

Such being some of the conditions of contaminated air, let us glance for a moment at their remedy. We have found that the contamination of air, whether chemical, microbic or particulate, is due to its employment in some way for the use and convenience of man. Air becomes polluted just as water becomes polluted. In each case a fundamental requirement of sanitary science is ignored. From its controlling importance and universal application we may term this requirement the cardinal

FIG. 6. THE LA PRELE DAM UNDER CONSTRUCTION. LOOKING DOWNSTREAM.

law of sanitation. This law demands that waste products shall be carried promptly from their source, kept always within control and be inoffensively disposed of.

It is much more difficult to observe this law in dealing with air than with water, and in no branch of sanitation will it be found possible to obey it perfectly. It is, nevertheless, our duty to keep its provisions prominently in mind, for no substantial success can be accomplished otherwise.

If the waste products of our furnaces and our factories were to be kept under control until they were utilized or otherwise destroyed, consider for a moment the immense saving in money and human life which would result. If persons sick with the lesser respiratory diseases, not to mention consumptives, were to isolate themselves as much as practicable, or, at least, refrain from visiting crowded assemblages, consider the enormous saving in life and health which would follow. If the filthy dust of our streets were to be kept from our lungs by efficient methods of street cleaning, consider the progress in decency and order, not to mention health, which this reform would accomplish.

The conservation of health has no better field for effective operation than systematic warfare against dust. With one notable exception, the use of oil on thoroughfares and railroads, no new method of combating this evil has been developed by sanitary science in recent years, while the quantities of dust produced and the harm which it has done have enormously increased with the growth of our cities. As matters stand, the greatest dust scavenger is the atmosphere. Into it we cast the dust of our houses with the same heedlessness with which we dump our sewage into the water courses. We do not stop to think that this air must serve to ventilate our dwellings and shops, and the lungs of our children and ourselves.

I am a strong advocate of flushing streets, but not of flushing them as we often see that operation performed in this country. The way in which we customarily do that work is wrong. A better and more economical method is employed in London, for example. There the material to be flushed away is first made thoroughly wet. The streets are sometimes sprinkled twice to lubricate them. They are then flushed by means of hose in the hands of intelligent workmen.

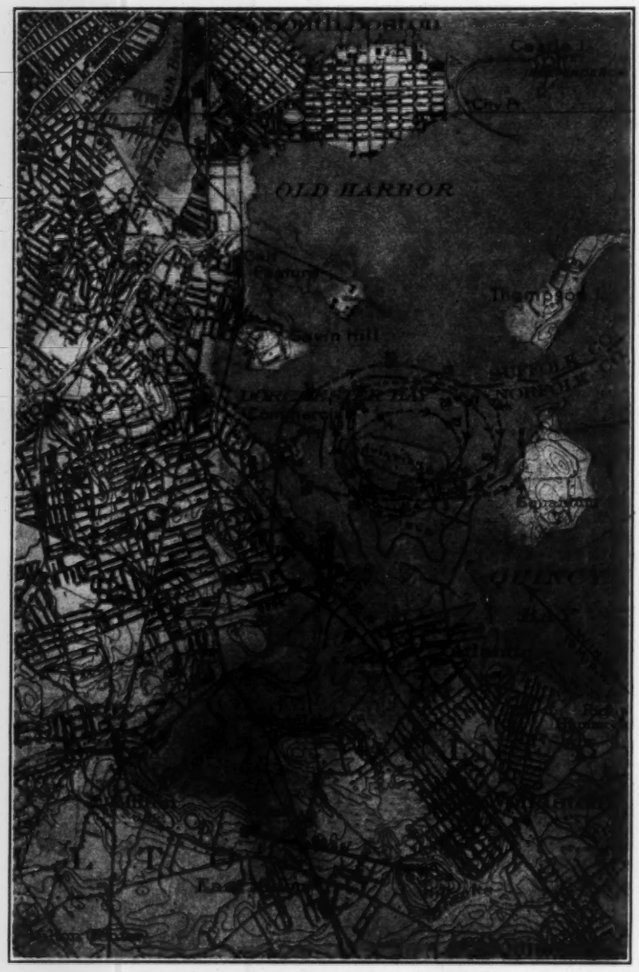
Measuring the Altitude Reached by Aeroplanes; Harvard-Boston Aero Meet.

By J. ALBERT HOLMES.*

In connection with the aviation contests and exhibitions at Atlantic, Mass., Sept. 3-13, 1910, rather elaborate preparations were made for determining the heights above the field reached by the competitors in the altitude contests.

The official contests took place each day between 2 and 6.30 p. m., and those for altitude late in the afternoon; so late in fact that it was difficult to read the verniers of the instruments.

It was assumed that a height of 10,000 ft. might be reached. The time, rather late afternoon, required for the best conditions of observation, a point or points to the south of the aviation field, in which position the sun would be behind the observers. A possible height of 10,000 ft. required that the points be located a distance of something over two miles from the field, in order to obtain vertical angles which could be conveniently observed with an ordinary transit. The aviation field at Atlantic is well located to fulfill these conditions, the high ground to the south furnishing the necessary observation stations in the most desirable positions. (See map.)



MAP OF AVIATION FIELD, SHOWING LOCATION OF BASE LINE A-B.

Prof. R. W. Wilson, of Harvard University, was in charge of the altitude measurements, and selected the location for the stations. The writer assisted in measuring the base line and was observer at Sta. B. Sta. B was in an open field on the Carey estate, East Milton, and Sta. A on the slope of Forbes Hill, Quincy.

Either station could be seen from the other, but as a direct measurement could not be made between, a traverse was run through adjacent streets, the angles closed on the base, and the length of the remaining side, the base line, computed. The length was determined as 6,236 ft. and its distance from the aviation field being about 2¾ miles, the vertical angle for a height of 10,000 ft. was about 35°. The elevation of each station above the field was determined by leveling from nearby bench-marks.

The H. I. at Sta. A was 127 ft., and at Sta. B 71 ft., above the field. The starting line, however, could not be seen from either station because of an intervening hill. There were also trees at the right of Sta. A, and at both right and left of Sta. B, which obstructed the view at the ends of long circuits until a considerable height had been attained.

Back of each station, in the line of the base, range poles were erected, which were covered with alternate strips of black and white cotton cloth and surmounted by a signal flag. Around the hub marking each station three stakes were driven flush with the ground, on which to place the legs of the instrument tripod, thus ensuring a quick and stable setup. Sun and wind shelters for the instruments were also provided. Telephone connections were installed between the stations and with Prof. Willson's office on the aviation field.

The instruments used had horizontal and vertical circles, one instrument reading to 1' the other to 20". The telescopes gave erected images, and that used by the writer had diagonal wires which crossed near the intersection of the vertical and horizontal crosshairs, thus eliminating the possibility of setting on the stadia wires.

The recorder at each station was also the telephone operator and was provided with head and breast attachment of receiver and transmitter. When notice had been received from the field office that a flight for altitude was to be attempted, both stations were called and the standard chronometer time given. The operators' watches were compared with this standard and the results recorded. (See sample notes.) At the same time the name of the aviator and the type of machine to be used were given.

When the aeroplane could be seen from both stations, the recorder at Sta. A would give the word to get ready, at which both observers trained their instruments on the aviator as being at the center of gravity of the machine. An answer of "all right" was then passed to Sta. A. Each observer now followed the movements of the aeroplane by turning the upper motion with his left hand, the lower motion having been set at zero on the base line, and moving the telescope up or down by means of the tangent screw on the vertical circle with his right hand. The signal "all right" was repeated back and forth until the recorder at Sta. A would say "set," at which the observers would cease moving the instruments and read to the recorder the resulting horizontal and vertical angles. At the same signal each recorder noted the time to the nearest second. The recorded time reduced to standard time served to identify corresponding observations. Eight series of observations were taken on five different days during the meet.

The resulting horizontal angles give the means of obtaining the horizontal distance to the aeroplane from each station and each vertical angle gives an independent calculation of the height, thus making a check on the vertical measurements of each instrument. A comparison of the values in Column 4, in the accompanying table gives an idea of how close these checks came. These differences are small except in settings Nos. 3, 7 and 27 of the series shown, which were taken on Brookins in a Wright biplane on Sept. 10, the day on which he made the record height of the meet of 4,725 ft.

A portion of the course over which Brookins flew on this day is shown by the dotted curves over the aviation field on the map. A sample of the notes taken on this day is also shown. The table gives the altitude for each setting, the rate per minute of ascent and descent and the apparent rate of advance.

It will be noticed in Column 4 that the differences in elevation found from Sta. B gave in nearly every setting a higher value for the altitude; this was due in part to a slight difference of time in setting at the two stations, for as the recorder at Sta. A called "set," the observer at Sta. B was delayed a small amount of time required for his recorder to repeat the signal. However the averages, when plotted as a profile, form a smooth curve, even where the differences were greatest. A study of this profile is interesting.

During the flight recorded in the table, the wind was blowing from the southeast at 10 miles per hour. Both Brookins and Graham-White were in the air trying for altitude and the engineers were instructed from the field office to follow Brookins. He was picked up at an altitude of 1,221 ft. at 5-38-40 p. m., and followed until 5-43-46 p. m., when instructions were received from the field to change to Graham-White, who was followed from 5-45-40 to 5-51-25 p. m., after which he disappeared from sight behind a tree near Sta. B.

Brookins was again picked up at 5-54-21 p. m., and as on the reappearance of Graham-White he was on his descent, observations on Brookins were continued until he reached his greatest height and returned to an altitude of 1,378 ft.

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TABLE SHOWING ALTITUDES AND RATE PER MINUTE OF ASCENT, DESCENT AND ADVANCE.

1	2	3	4	5	6	7	8		9	10	11
No. of Setting.	Elv. by Sta. A, ft.	Elv. by Sta. B, ft.	Diff. Elv.	Av. Elv.	Int. of time, min.	Alt. diff., ft.	Rate of ascent ft. per min.		Advance, ft.	Rate of advance, ft. per min.	Remarks.
1	1,219	1,222	+ 3	1,221							5-38-40 p. m.
					1.83	295	161		2,600	1,421	
2	1,510	1,521	+ 11	1,516							Against wind
					1.23	285	231	Av. 189	3,000	2,439	Flying East
3	1,682	1,920	+238	1,801							Flying East
					1.02	193	189		2,700	2,647	Flying East
4	2,003	1,985	— 18	1,994							
					1.02	26	25		1,300	1,274	
5	2,018	2,021	+ 3	2,020							With wind
					10.52	1,418	135				
6	3,431	3,444	+ 13	3,438							
					.90	71	79		3,800	4,222	Flying East
7	3,413	3,605	+192	3,509							
					2.00	203	101		3,300	1,650	Against wind
8	3,710	3,714	+ 4	3,712							
					.67	50	75		700	1,045	Flying West
9	3,761	3,762	+ 1	3,762							
					.75	64	85		900	1,200	Flying West
10	3,801	3,850	+ 49	3,826							
					1.08	35	32		1,200	1,111	Flying West
11	3,857	3,864	+ 7	3,861							
					.92	8	9		1,000	1,087	Flying West
12	3,872	3,865	— 7	3,869							
					1.33	115	87		1,800	1,353	With wind
13	3,985	3,983	— 2	3,984							
					.60	56	93		1,900	3,166	
14	4,037	4,043	+ 6	4,040							
					.73	51	70		2,400	3,288	Flying East
15	4,090	4,091	+ 1	4,091				Av. 72.5			Against wind
					.83	109	131		2,400	2,892	
16	4,200	4,200	0	4,200							
					.75	94	125		1,700	2,267	Flying West
17	4,293	4,295	+ 2	4,294							
					.65	45	69		1,500	2,308	Flying West
18	4,337	4,340	+ 3	4,339							
					.87	83	95		1,900	2,184	Flying West
19	4,417	4,426	+ 9	4,422							With wind
					.88	53	60		2,100	2,386	
20	4,470	4,479	+ 9	4,475							
					.78	25	32		2,000	2,564	
21	4,496	4,503	+ 7	4,500							
					1.02	38	37		2,900	2,843	Flying East
22	4,529	4,547	+ 18	4,538							
					.58	34	59		1,800	3,103	Flying East
23	4,568	4,576	+ 8	4,572							
					.70	49	70		2,100	3,000	
24	4,616	4,625	+ 9	4,621							Against wind
					.82	24	29		2,200	2,683	
25	4,644	4,645	+ 1	4,645							
					.87	80	92		2,700	3,103	
26	4,718	4,732	+ 14	4,725*							Flying West
					1.60	817	511		3,700	2,313	With wind
27	3,973	3,843	—130	3,908							
					.77	556	722		4,200	5,455	Flying East
28	3,340	3,364	+ 24	3,352				Av. 623			Against wind
					2.17	1,559	719		7,300	3,364	
29	1,788	1,797	+ 9	1,793							Flying West
					.83	415	500		2,700	3,253	With wind
30	1,374	1,381	+ 7	1,378	....	...	...		.....	.....	6-17-28 p. m.

*Highest altitude attained.

SAMPLE PAGES OF FIELD NOTES.

Left-hand page.

Notes on Altitude—Harvard-Boston Aero Meet—September, 1910.

Sta. B—Carey Estate, East Milton, Mass., Saturday, p. m., Sept. 10, 1910.

Standard Time.	Engineer's Time.
3-41-00	Sta. B. 3-40-35
	Sta. A. 3-39-23

Height of Inst. 71.0 above aviation field.

Inst. Buff Mining Transit No. 6463 (new 1909).

J. Albert Holmes—observer.
J. Walsh—recorder.

Right-hand page.

Machine—Wright Biplane.
Operator—Walter Brookins.

Horz. angle.	Vert. angle.	Eng. time.	Remarks.
88-07-00	4-24-00	5-38-15	
84-30-	6-28-	40-05	
71-44-	7-55-20	41-19	
64-53-40	7-08-	42-20	
67-06-	6-50-40	43-21	
	Changed to Grahame-White.		
104-53-40	4-27-00	45-15	
105-28-	4-28-	46-18	
102-13-	7-56-	47-52	
94-51-	10-17-40	48-48	
76-48-30	13-18-	50-00	
56-12-	11-26-	51-00	
		5-52-00	Behind tree.
	Changed to Brookins.		
88-15-00	12-00-40	53-56	
75-00-	11-48-40	54-50	
68-34-40	14-19-	56-50	
70-18-40	15-11-	57-30	
72-42-	16-16-	58-15	
76-47-40	17-20-	59-20	
81-07-	17-40-	6-00-15	

above the field at 6-17-28 p. m., after which it became too dark to follow him.

Brookins' rapid ascent of 189 ft. per minute, as shown by the first three settings, was made against the wind. Following this he flew nearly at a level for one minute at an altitude of about 2,000 ft. It was at this point that the observers shifted to Graham-White.

After 10.52 minutes Brookins was again taken up, during which time he had risen an additional 1,400 ft. to a height of 3,438 ft. The rest of his ascent was gradual, the average being 72.5 ft. per min. The direction and rate of the wind may have been different at this altitude.

It is interesting to note in the table the differences in the rate of advance per minute while flying east and west and vice versa. It will be seen from Column 10 that the westward flights were at much slower rates than the eastward. The reason for this, however, is not apparent.

Thirty settings were made on the aeroplane during this flight with a minimum interval of 35 seconds between settings and an average interval of one minute.

While there is nothing new in the methods thus employed in determining altitude, the conditions were such as to call for smoothly working instruments in perfect adjustment, and the observers and recorders had necessarily to be on the alert and have their wits about them and their attention entirely on their work.

Approximate heights obtained by sextant observations were announced on the field after each flight; barometers and other apparatus were also sent up on the aeroplanes, but the official altitudes were computed from the observations described above and were worked out each evening and given to the press for publication in the morning papers.

The solution of the triangles is quite simple, the formula for the side a being $a = \frac{c \sin A}{\sin C}$, and for b, $b = \frac{c \sin B}{\sin C}$. To the logarithms of a and b thus found are added respectively the log tangents of the vertical angles at A and B. These altitudes are then corrected by adding the corresponding H. I. and the operation is completed.

To reduce the computation to a single operation, Mr. Duncan, Prof. Willson's assistant, devised the following formula, in which:

c = length of base line, 6,236 ft.
x = height of aeroplane above instrument.
a = vertical angle at Sta. A.
A = horizontal angle at Sta. A.
β = vertical angle at Sta. B.
B = horizontal angle at Sta. B.
q = H. I. above field at Sta. A.
m = H. I. above field at Sta. B.
a = side opposite angle A.
b = side opposite angle B.
c = side opposite angle C.
C = angle at the aeroplane.

Since

$$a = \frac{c \sin A}{\sin (A + B)},$$

and

$$x = a \tan \beta,$$

combining gives:

$$x = \frac{c \sin A \tan \beta}{\sin (A + B)},$$

or it may be written:

$$x + m = c \sin A \tan \beta \operatorname{cosec} (A + B) + m.$$

And for the other Sta.

$$x + q = c \sin B \tan \alpha \operatorname{cosec} (A + B) + q,$$

which presents a simpler form for use with logarithms.

WATER POWER DEVELOPED BY THE SANITARY District of Chicago, at Lockport, Ill., is now yielding a handsome profit. For the six months ending July 1, 1910, President Robert H. McCormick reports the gross receipts of the power plant at $258,000. Operating expenses and repairs were $78,000, leaving a margin of $180,000. After charging off from this $36,000 for depreciation and $82,000 as interest on the cost, the plant showed a clear profit for the six months of $61,800. This profit was made entirely from the current sold for commercial purposes, as the current which is furnished from the power plant to the city of Chicago and other municipalities is charged to them at actual cost. The Citizens' Association of Chicago claims that the saving to the cities using the Sanitary District current for public lighting is probably more than $200,000 per year at the present time.

THE INADEQUACY OF SEWAGE PURIFICATION as a protection to a public water-supply is forcibly brought out in a report on the improvement of the water-supply of Ottawa, Ont., recently made by Mr. Allen Hazen, M. Am. Soc. C. E., of New York City. In the portion of the report devoted to the possibilities of purifying the water of the Ottawa River, Mr. Hazen refers to the sewage of Aylmer, a village on the river a few miles above the Ottawa water-works intake, as follows:

The village of Aylmer has just been building sewers. It has been proposed to build a septic tank through which the sewage would be passed before discharging it into the river. This will be built if one-half of the cost is paid by Ottawa.

I think it may be worth while to do this and secure whatever purification may be obtained in this way. At the same time it must be recognized that the purification of sewage from the standpoint of pollution of water-supply that would be obtained in this way, or by any other method that it is reasonably feasible for Aylmer, or other like villages, to adopt, will be a very poor protection against the infection of the Ottawa River water.

In considering the water-supply situation I should practically disregard the effect of any such works and should consider the matter precisely as if all the sewage were discharged entirely without treatment.

The works for the treatment and purification of sewage have been studied, designed and built almost exclusively with reference to the conditions resulting from the gross pollution of rivers are commonly spoken of as "local nuisance." This is especially true of European sewage treatment works which are much larger and more numerous than those in this country and from which most of our knowledge of sewage treatment has been obtained. It has only happened in rare and exceptional cases that sewage has been treated with the express purpose of preventing the pollution of water-supply obtained from the stream below.

Septic tanks, sprinkling filters, contact beds, are directed to the removal of those gross matters which would produce conditions in the water apparent to the senses. They have not been designed, and should not be expected, to remove the infectious matter that is injurious in a water-supply. If the removal of such infectious matter is really necessary it could be accomplished by other means, such, for instance, as the passage of all the sewage through fine-grained sand, or by its treatment with powerful disinfectants. Passing the sewage through fine-grained sand is a good way of doing this. It is more difficult where the winter temperatures are very low and the sewage quantities small, and it would be difficult to keep the sand from freezing up. Sewage clogs fine-grained sand rapidly, and constant attention is required to keep the surface of the sand open so that all of the sewage may at all times pass through it.

The disinfection of sewage also calls for constant and conscientious supervision by one understanding just what is to be accomplished and how it is to be done.

As a practical problem the treatment of the sewage from Aylmer and all the other villages upon the catchment area so as to prevent the infection of the water is altogether too difficult, uncertain, and unsatisfactory a procedure to be really worth attempting. Much greater return will be obtained from a given investment in the purification of the water-supply, and it is along this line that I recommend that this problem be approached.

The Highest Bridges in the World.

The height of a bridge above the stream or valley which it crosses is sometimes a matter of interest merely on account of being exceptional, but in some cases it presents special difficulties in construction and may influence the design of the structure or the method of its erection. The list of notable high bridges given below has been compiled by us with some care and includes a number of the highest bridges of the world. A list of 14 high bridges was given in our issue of March 12, 1892. This was headed by the St. Giustina Bridge, which still remains at the head of the list, but the Garabit Bridge then ranked second. So far as known the height given is the distance from low water level to the level of the rail or roadway.

Bridge.	Height above water, ft.	Length, ft.	Date opened.
1. St. Giustina (Tyrol).....	460	197	1889
2. Fades (France)	435	1,330	1909
3. Zambesi (So. Africa).....	420	650	1905
4. Garabit (France)	406	1,852	1884
5. Viaur (France)	380	1,508	1902
6. Namti (China)	350	220	1908
7. Crooked River (Oregon, U. S. A.)	350	360	(not bit.)
8. Muengsten (Germany)	350	1,525	1897
9. Rio Grande (Costa Rica)..	340	800	1902
10. Loa (Bolivia)	336	800	1888
11. Constantine (Algeria).....	330	1,500	1910
12. Pecos (Texas, U. S. A.)...	328	2,180	1892
13. Gokteik (Burma).....	320	2,260	1900
14. Sitter (Switzerland)....abt.	315	394*	1910
15. Belly River (Can. Pac. Ry)	307	5,327	1909
16. Kinzua (Penna., U. S. A.) old	301	2,052	1882
Kinzua (Penna., U. S. A.) new	301	2,052	1900
17. Wiesen (Switzerland).....	289	180†	1909
18. Bristol (England)	285	705	1864
19. Cerveyrette (France).....	280	246	1890
20. Kentucky River (U. S. A.) old	275	1,138	1877
Kentucky River (U. S. A.) new	306	1,138	1910
21. Verrugas (Peru) old.....	256	575	1872
Verrugas (Peru) new.....	256	575	1900
22. Malleco (Chile).....	248	1,140	....
23. Portage, U. S. A.....	235	850	....
24. Moldau (Bohemia).....	214	886	....
25. Douro (Spain)	201	1,157	....

*Central span; deck truss. Total length of bridge.
†Central span; stone arch. Total length of bridge, 689 ft.

The list is not assumed to be complete, and there are probably other structures which might be interpolated, especially near the bottom of the list. The St. Giustina and Cerveyrette bridges are single steel-arch highway spans over mountain gorges; the length of span is 197 ft. and 172 ft., respectively. The Clifton suspension bridge (with eye-bar chains instead of cables) and the Wiesen stone arch are the only other highway bridges on the list.

The Garabit bridge has steel deck truss spans on steel towers, and a steel arch of 540 ft. span. The Fades bridge has a three-span continuous lattice deck truss (spans 378, 472, 378 ft.) on masonry piers. The Zambesi River bridge, on the Rhodesia Railways, has a 500-ft. steel arch at the gorge of the great Victoria Falls. The Viaur bridge has a 721-ft. three-hinged steel arch, extended at each end to form semi-arch cantilever arms reaching to the approaches. The Rio Grande bridge is of a very similar design. The Namti bridge is a "triangular" arch of 180½ ft. span, with towers on its haunches to carry a line of deck spans. The Sitter bridge is a single-track, steel-truss deck bridge on high stone towers with arch viaduct approaches. The Crooked River bridge on the Oregon Trunk Ry. (not yet built) will be a steel arch of about 360-ft. span. The Constantine Bridge has a masonry arch as its main span.

The Muengsten bridge is a fixed-end steel-arch bridge with the arch spanning 357 ft. The Loa bridge on the Antofagasta Ry. is a steel viaduct. The Pecos bridge of the Southern Pacific Ry. is similar but with steel deck cantilevers on two steel towers for the river and flanking spans. The Gokteik bridge on the Burmah State Railways is a steel viaduct with a 40-ft. tower spans and 120-ft. intermediate spans. The Belly River (or Lethbridge) bridge on the Canadian Pacific Ry. is a viaduct with 67-ft. tower spans and intermediate spans of 98 ft. 10 ins.

This structure is notable also for its great length (5,327 ft.), and it is undoubtedly the greatest viaduct in the world; the Gokteik viaduct in Burma ranks second in length. The Kinzua bridge on the Erie Ry. is a noted steel viaduct, and was rebuilt in 1900 on account of increases in loads.

The Kentucky River bridge (High bridge) on the Cincinnati Southern Ry. is being rebuilt with the rail level 30 ft. higher than on the original structure. The Verrugas bridge as built in 1872 had three steel towers carrying three deck spans of 100 ft. and one of 125 ft.; as rebuilt in 1900 it has two towers (30-ft. span), a central cantilever span of 235 ft. and anchor arms of 140 ft. The Douro Bridge has a main steel arch span supporting the deck trusses of a viaduct.

Converting a Steel Trestle Into a Reinforced-Concrete Trestle.

A recent interesting development in the use of reinforced concrete for railway bridges and viaducts is the conversion of a steel trestle to a reinforced-concrete structure by encasing its original columns and struts with concrete in which is embedded the necessary additional amount of steel reinforcement. The purpose of this work was to obtain a stronger structure in order to provide for the increase in wheel loads, and careful investigation showed that it would be cheaper to effect this in the way described than to build a new steel structure. Fig. 1 is a view of part of the completed work.

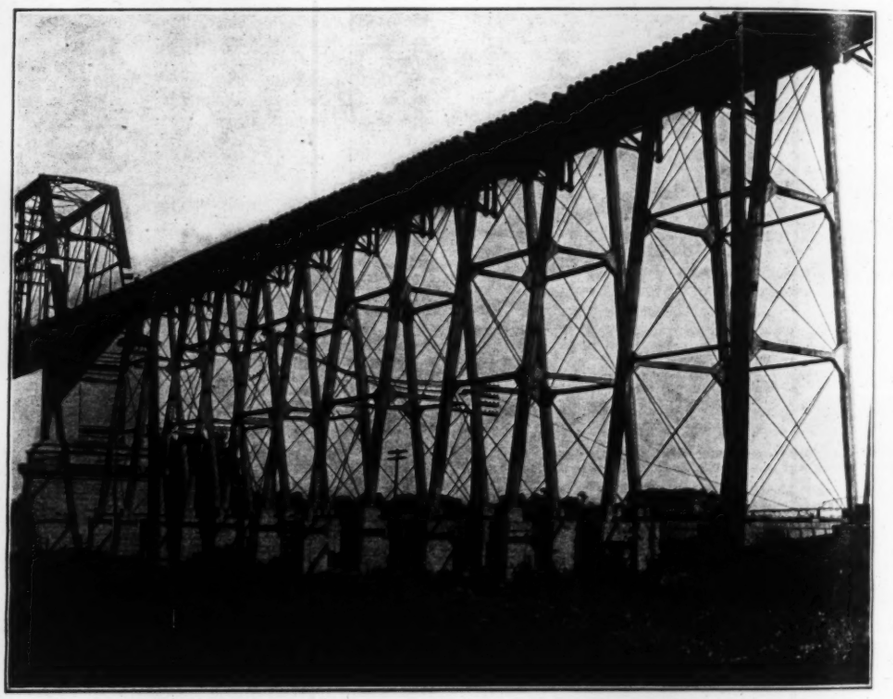


FIG. 1. A STEEL TRESTLE CONVERTED INTO A REINFORCED-CONCRETE TRESTLE.
(Old Steel Phoenix Columns Left in Place); Approach to the Missouri River Bridge of the Wabash Ry. at St. Charles, Mo. A. O. Cunningham, M. Am. Soc. C. E., Chief Engineer.

The trestle in question is on the Wabash Ry., and forms the approaches to the Missouri River bridge near St. Charles, Mo. It is a single track structure. The river spans were originally constructed in 1871 and consisted of four Fink and three Warren trusses, having a total length of 2,177 ft. 6 ins. Between 1880 and 1885, these spans were removed and replaced by four spans of Whipple double-intersection trusses and three spans of Warren triangular trusses. The approaches were constructed in 1884 and consist of towers composed of Phoenix columns. Timber stringers are used to span the towers and between the towers; their length being 16 ft. The bridge has a total length of 6,541 ft. (including the trestle approaches) and a maximum height of 45 ft. It was designed for a live load of Cooper's E-25 loading, but new structures on this road are now designed for a live load of the E-50 loading, and it was desired to strengthen this trestle to meet the new conditions.

The plan outlined above was proposed by Mr. A. C. Cunningham, M. Am. Soc. C. E., Chief Engineer, to whom we are indebted for plans and information. The work was done by the W. P. Carmichael Co., of Williamsport, Ind. It was done under force account, as it was of such a character that estimates could not well be made in advance. It was commenced in May, 1910, and completed in August, 1910. The total cost was about $17,000.

The columns and struts are four-section Phoenix columns. The former are converted into octagonal concrete columns, 18 ins. diameter over the faces, reinforced by a spiral wrapping of No. 6 wire having a pitch of 2 ins. The general design is shown in Fig. 2, with the forms and reinforcement. The base is a rectangular concrete block, reinforced by a cage of steel rods. The concrete struts (Fig. 3) are 7½ × 7½ ins., each reinforced by eight ½-in. rods, around which is a wrapping of heavy woven chicken wire. Gussets unite the struts with the columns. The diagonal rods are left in place, but are not concreted, as such bracing is not required in the reinforced-concrete structure. The concrete was composed of 1 part Portland cement and 3 parts coarse sand. This was made quite wet so as to ensure a dense mixture and a complete surrounding of the steel reinforcement. The paint was not removed from the columns before concreting. The interior of the columns had been filled with concrete some years before, as noted below.

The forms were of ⅞ × 5½-in. plank, braced by outside ribs about 2 ft. apart. They were built in lengths of 14 to 16 ft. to fit between the special forms used at the base, the cap and the strut connections.

The reinforced concrete bases were cast first. The spiral reinforcing was threaded on the columns and held in place by steel spacers and anchored to the columns. Then the boxing for the forms was placed. When a sufficient number had been placed, concrete was run into them from a work train on the trestle. This train consisted of an engine, caboose and flat car, the flat car containing the materials and the concrete mixer. This train, when all was ready, filled about eight column forms per day.

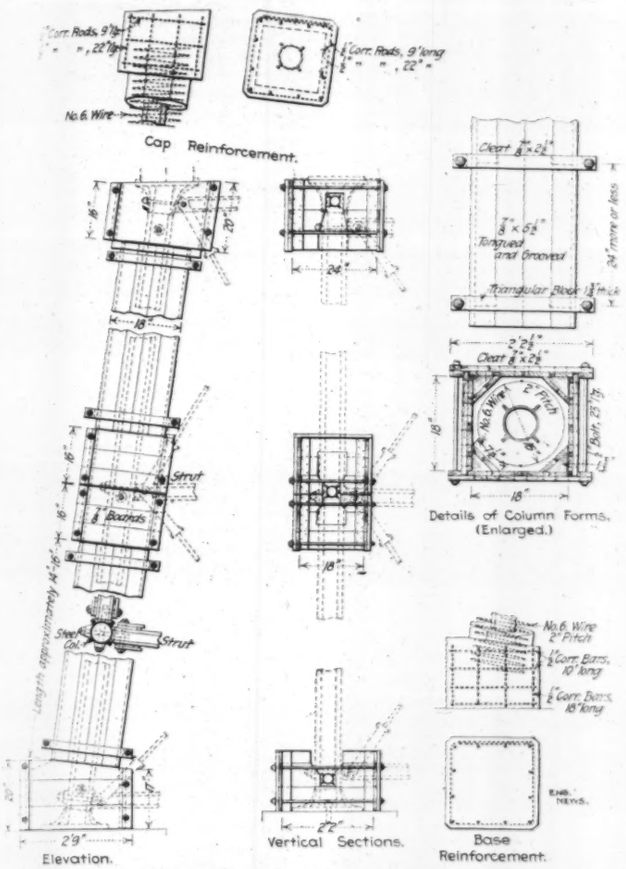


FIG. 2. FORMS AND STEEL REINFORCEMENT FOR CONCRETING THE PHOENIX COLUMNS OF THE OLD TRESTLE.

About seven or eight years ago, the columns were filled with concrete, and according to tests previously made by this railway with columns so filled, the strength had been increased in this way about 10%. However, as it was necessary to further increase the strength of the columns, the reinforcement work that has just been done was decided upon about two years ago. In order to ascertain whether vibration or effect of the weather would be detrimental to the concrete placed around the columns, one bent of four columns was constructed about 1½ years ago. The concrete on these trial columns appeared to be of very good quality, and passed through the winter without any detriment. It was considered safe therefore to strengthen the other columns in a similar manner.

Before this was done, however, a test was made on one Phoenix column that was in stock. More tests would have been made, but this was the only column that was on hand. The column was of the same size as those in the St. Charles Bridge approach and was 27 ft. long. A piece 5 ft. in length was cut from this column, and was tested as a steel column of this length. The rest of the column (22 ft. long) was strengthened with concrete and reinforced exactly as was done in the St. Charles bridge approach. Both the 5-ft. plain steel column and the 22-ft. reinforced column were tested under the direction of Prof. A. N. Talbot, of the University of Illinois. From these tests it was found that the column strengthened with concrete and spiral reinforcing was about twice as strong as it was previous to the application of the reinforcement. It is believed that the columns so reinforced will be strong enough to carry the heaviest engines in existence, and it must be remembered that the columns so strengthened will give ample indication before failure takes place.

Formerly each column supported two 8 × 16-in. wooden stringers on a span of 16 ft. These were strengthened about eight years ago by truss rods and are of ample strength for the engines that are being used at present. It has been decided that when the timber stringers decay, each will be replaced by one 15-in. 60-lb. I-beam. In other words, there will be two steel stringers under each rail instead of the two wooden stringers at present in use.

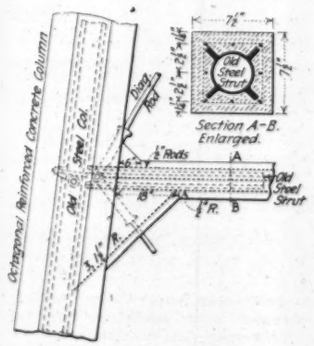


Fig. 3. Reinforced-Concrete Struts, Embracing the Old Steel Struts.

The Report of the Committee on Uniform Mining Laws for the Prevention of Mine Accidents.

The October Bulletin of the American Institute of Mining Engineers contains the report of a committee appointed at the meeting of the American Mining Congress, at Denver, Colo., in November, 1906. The committee was made up of Mr. Walter R. Ingalls, Chairman, Messrs. J. Parke Channing, James Douglas, James R. Finlay, and John Hays Hammond. This committee presented progress reports at the meetings of the Congress in 1907, 8 and 9. At the last meeting it was also authorized to present this report not only to the Congress but to the American Institute of Mining Engineers and the Mining and Metallurgical Society of America.

The work of the committee has been greatly aided by Mr. Frederick L. Hoffman, Statistician of the Prudential Insurance Co., of Newark, N. J. Mr. Hoffman collected the available statistics of fatalities in the metal mines of the United States, and in the present report he has supplemented this with statistics showing the accidents in Canada and the accidents in the mines of most other nations of the world.

The statistics collected indicate that the loss of life in metal mining in the United States is fully as great as in coal mining. The figures collected show an average of 3.09 miners killed per annum per thousand miners employed, compared with 3.13 miners killed in coal mines. The statistics for coal mines, however, are so much more complete and the accidents are so much more fully reported than in metal mines that the committee concludes that metal mining is probably the more dangerous.

This matter is of great importance, because the public has its attention chiefly fixed upon accidents in coal mines. The reason for this is that coal-mine accidents very often affect a larger number of men, and, consequently, are heralded far and wide by the newspapers. The accidents which occur in metal mining, on the other hand, where only one or two men are killed at a time are practically unknown to the public.

The chief work of the committee has been the preparation of a draft for a proposed uniform law. In the preparation of this draft the committee has aimed to devise a statute which will be effective and which will fix responsibility upon operator, superintendent, foreman and miner, respectively. It has provided suitable penalties for failure on the part of any one of them to obey the law. The enforcement of the law is charged primarily upon the inspector of mines. The committee frankly recognizes that the conditions of mining are so widely different in various parts of the United States that some changes and alterations in its proposed statute may be necessary to conform to local conditions. The present draft of the statute it considers as preliminary, therefore, and invites criticism for its assistance in preparing a final report.

The committee considers that an adequate system of mine inspection is quite as necessary as a comprehensive mining law. To secure such a system of mine inspection, however, much more liberal appropriations must be made by the respective states. At present the State of Colorado makes the largest appropriation for inspection of metal mines, to wit: $25,000 per year. Other important mining states appropriate only $10,000. The committee declares such appropriations to be wholly inadequate in all the states and territories west of the Rocky Mountains and advises that $50,000 to $100,000 per state per annum is necessary if efficient mine inspection is to be secured. The committee's report concludes as follows:

Consequently, the committee emphasizes strongly that the reduction of loss of life in mining is dependent chiefly upon the money that the people of the respective states are willing to spend for the enforcement of their mining laws, and in such expenditures the committee urges great liberality.

It is essential that mine inspection be impartial—absolutely free from all political, personal and selfish interests; and, moreover, that it be competent. In its draft for a law, the committee has incorporated, after very careful consideration, qualifications for mine inspectors, which, in its opinion, will provide the essential conditions stated above.

The draft of the proposed Act covers 40 pages of the American Institute of Mining Engineers' "Proceedings" for October, and can be obtained from the Secretary's office, 29 West 39th St., New York City.

A NEW METHOD OF SURFACING macadam roads to withstand heavy traffic, as from automobiles, has been devised by Mr. C. H. Hoyt, U. S. Superintendent of Road Construction, for experiments under way at East Ave., Ithaca, N. Y., as a part of the road experiments being carried on by the U. S. Office of Public Roads and Cornell University jointly. This method of Mr. Hoyt's is described in a contribution to "The Cornell Civil Engineer," October, 1910, and is the use of a "prepared filler." It was devised after a study of the effect of automobile traffic in destroying ordinary macadam by loosening up the stone of the road metal, so that the fine material which bound the coarser stone together was easily driven out or blown away. The idea of the prepared filler is to secure a binder substitute for such finer material in the top course only. The bottom courses of the road have been built and rolled as for an ordinary macadam. The top course of stone was laid as usual, but before rolling this was covered with a layer of prepared filler made from stone chips, sand and bituminous material, heated and mixed thoroughly in a concrete mixer. This layer, about 1½ ins. in depth, was harrowed in with a spike-tooth harrow until the top course stone began to appear through the filler. The road was then rolled until it was firm, and on one section a light paint coat of bitumen was applied, which was then covered with stone chips and rerolled. On a second section a thin surface coat of about ½ in. of the prepared filler was spread and the road rerolled. It is stated that not as much difficulty was encountered in properly building the road thus as in securing a good bond of road metal by the penetration method of applying the bitumen.

Tests of Various Road Surfacing Materials by the Ohio State Highway Department.

The disintegration of macadam roads by the removal of the dust binder under the wheels of rapidly moving automobiles has long been a subject of great importance to highway engineers, both in this country and abroad. Various patented preparations for surfacing such roads have been in the market for some time and it was with a view of determining the relative wearing qualities of these materials that the Ohio State Highway Department has built a series of test sections of road.

The details of the construction of this test road are reprinted below from Bulletin No. 12 of the Ohio State Highway Department. Under each of the 17 experimental sections described we have also inserted a paragraph reprinted from Bulletin No. 13, which has been recently issued, describing the present condition of that section after one year's wear.

An experimental road has been built, giving each of the materials tested a section 400 ft. in length with a roadway 16 ft. wide, the sections being connected and forming a continuous road, all parts receiving very nearly the same amount of travel.

In preparing for this work, letters were addressed to the different firms advertising road-building materials and they were advised of the intention to build this experimental road and of its scope and purpose, and the hope was expressed that all manufacturers would show their confidence in their product by participating in the work. With few exceptions the firms addressed have complied with the request and have applied their materials on the road. The Highway Department has paid for all labor and materials required in this work, but has stipulated that each firm should furnish an expert to superintend its particular section, in order that the work should be constructed exactly according to the manufacturer's ideas.

In addition to the above-mentioned work, a few sections have been constructed using Portland cement as a binder.

A census of the travel was taken for two weeks, beginning November 29, 1909, and a table showing the result is included in this bulletin. The weather during almost this entire time was inclement, and the travel was restricted to those who must of necessity go over the road. (The table which we have printed in connection with this article is from a later census and shows a fairer estimate of the traffic during ordinary weather.)

The surface of the road has been carefully leveled, and it will be possible to ascertain the amount of wear by releveling at any time. It is the intention of the department to issue additional bulletins in the future, giving the results of the wear of the road and the relative wearing qualities of the various materials.

Selection and Location of Road.

In selecting a road for this purpose, it was desirable that it should be easily accessible, that it should be well traveled, and, if possible, in the condition of an unimproved country road.

The fact of Columbus being centrally located, an important railway center, and the state capital, resulting in its being frequently visited by people from all parts of the state, also the desirability of having the road as near as possible to the Highway Department offices, decided the question of its location near this city. In making the selection it was impossible to find a well-traveled road near the city that had not been improved in some manner.

Nelson Ave. was selected as the road best suited for the purpose of any in the vicinity of Columbus. This road extends north from Broad St. to St. Mary's Academy, and is the first road west of Alum Creek. It is accessible by the Columbus, New Albany & Johnstown Interurban Ry., and is but 20 minutes ride from the city. Cars may be taken at the corner of Long and High Sts. It provides a convenient means of entering the city for travel from the Sunbury Road, and the amount of wagon and automobile traffic is large.

This road had been macadamized several years ago, and there was a very good foundation over the distance which has been used for this experiment.

Construction.

In the construction of the road arrangements were made with a contractor to do the work on a force account, allowing him 15 per cent. of the pay-roll for the use of his outfit and his own services. In preparing the road to receive the various treatments, the old road was spiked up, new stone was added, and it was rolled and watered to the condition of a finished water-bound surface.

In the beginning an attempt was made to use macadam stone from all of the principal quarries in the state, building each section from a different quarry, but the delivery was so uncertain and irregular that we were compelled to abandon this feature.

It was not possible to separate the cost of the foundation of each section, and this expense was kept as a whole for all sections receiving like treatment, and in determining the cost of any section the cost of application of the binder was kept separate and added to the proportionate cost of its base to determine the cost of the section.

During the months of July and August good labor was plentiful at $1.50 per day, but beginning with Sept. 1, we had to pay $1.75 per day for labor that was not as efficient as that for which we had formerly paid the lower wages. This condition affects unfavorably the sections constructed after Sept. 1, as they will show a higher proportional labor cost than the sections constructed before that date.

In justice to manufacturers furnishing the materials for this work, it is but fair to state that the relative cost of the sections is not in proportion, and the cost of each per foot is considerably higher than it would be were the sections a mile or more in length. This is owing to the small quantity of material required for each 400-foot section, which made it impossible to handle large quantities at one time, and prevented systematic, routine work on the part of laborers, teams and machinery. The wide variance in freight rates and the nature of the materials used also contributed to this discrepancy.

In the descriptions that follow the sections are taken up in the order of their location, beginning at the north end, near the entrance to St. Mary's Academy, and proceeding from there south to the end of the work.

Experiment No. 1—Glutrin.

This material was applied on a well-constructed, two-course macadam road that had been thoroughly rolled and bonded. The company furnishing this material does not give the process of its manufacture. It is said to be prepared from materials produced during the manufacture of cellulose. It is described by the manufacturers as a "calcium-magnesium-ligno-sulfonate, and at the specific gravity of 1.26 at which it is sold, contains probably about 18.00% of glucosides." It is a viscous liquid, soluble in water, and in addition to its binding qualities, it is claimed to form a chemical action upon the road material that increases the flow of the binder, probably silicate of soda and silicate of potash, which results from the action of water upon the road metal.

The surface of the macadam was sprinkled with water, and while it was still damp, glutrin was applied by sprinkling with an ordinary road sprinkler. Two applications were made, a day elapsing between the first and second applications. The road was ready for travel in four hours after each application.

The manufacturers of this material were permitted to apply it in the manner they desired, and under this arrangement about one gallon per square yard was used. When the work was completed there was an excess of binder remaining on the surface, which assumed the appearance of little pools with a glassy surface. After a few rains this excess material disappeared. It would seem that a less amount of material might have given as good results.

A few days after the second application the road was remarkably hard, and has continued in good condition up to the present time. This treatment is of an entirely different nature from the ordinary oils and tars, and the effect of the winter season upon it will be watched with much interest.

The cost of this application is as follows:

Crushed stone	$191.18
Labor on macadam	242.52
Glutrin (711.9 gallons at 15c)	106.79
Freight and transfer	14.69
Labor applying Glutrin	5.60
Total	$560.78

This material is manufactured by The Robeson Process Co. of Au Sable Forks, N. Y.

The present condition of this section is as follows: Except for a brownish discoloration, this work has the appearance of water-bound macadam. Undoubtedly the application of Glutrin hardened the surface at the time it was applied, but by the end of the winter this condition had disappeared. Good results could doubtless be obtained by the application of this material each year.

Experiment No. 2—Standard Macadam Asphalt Binder.

The section of road on which this treatment was applied was first prepared in the usual manner of treatment for the lower course of a water-bound macadam road. Crushed limestone, ranging in size from 3 ins. to 1½ ins., was then spread to a depth of about 3 ins. This course was then rolled with a ten-ton roller until it presented a fairly smooth and uniform surface. The asphaltic binder, which had been heated in a small tank at the side of the road, was then applied by means of hand sprinkling cans. About 1½ gals. of the binder was used for each square yard of surface treated. Screened screenings varying in size from 1½ to ¾ of an inch were then spread upon the road and the roller again brought into use. Additional screenings were added where the binder appeared on the surface, and this work of rolling and adding screenings continued until no more binder appeared on the surface. [illegible] portion of this section a second coat of the binder, consisting of from ¼ to ⅓ gals. per square yard, was applied, followed by another coat of screenings and more rolling.

The cost of this section is as follows:

Crushed stone	$191.18
Labor on macadam	190.52
Labor on top course	54.99
Total	$416.69

No charge was made by the company for the binder used in this work. This material is manufactured by the Standard Oil Co.

This section is at present in good condition. The asphalt has exuded to the extent that it covers about one-half of the surface and shows plainly the marks of the horses' shoes.

Experiment No. 3.—Pioneer Asphalt Cement.

The material used as a binder in this experiment is refined from rock asphalt mined in Utah. In the construction the foundation course was finished as a water-bound macadam road, thoroughly rolled and bonded. The second layer was composed of stone ranging in size from 1½ to 2½ ins. This was rolled to a finished depth of about two inches, no water being used. One-half to ¾-in. screenings were broomed into the surface in a quantity sufficient to reduce the voids about 50 per cent. The asphaltic cement was then poured at a temperature of between 390° and 410° F., until all of the stone was thoroughly coated. When the coating had cooled, a thin dressing of screenings was sprinkled over the surface. These screenings were sprinkled but a short distance ahead of the roller, which followed immediately after the screenings were placed. The screenings were sprinkled at first in a thin layer, and as the rolling proceeded more screenings were added, until the coating had absorbed all the screenings which it was possible to absorb. The quantity of the binder used was 1¾ gals. per square yard.

The cost of this section is as follows:

Crushed stone	$191.18
Labor on macadam	190.52
Pioneer asphalt	77.24
Freight	61.22
Labor on top course	143.10
Total	$663.26

This material is manufactured by the American Asphaltum and Rubber Co., of Chicago, Ill.

In this section at present all of the pieces of stone are perfectly bound. No excess of binder is in evidence, the surface is smooth, and its whole condition is excellent.

Experiment No. 4—Tarvia "X."

In the preparation of Tarvia X, ordinary coal tar is heated to drive off the water and ammonia. The manufacturers have not seen fit to state what further treatment, if any, is given.

The road was prepared for this treatment in a manner similar to section No. 3, except that the stones in the top course were from 1½ ins. to 3 ins. in size. No screenings were used. When this course was thoroughly dry, the refined tar, under pressure, at a temperature of from 250° to 300° F., was spread over the surface by means of a hose attached to a tank wagon. The tank was hauled by a steam roller to avoid the displacement of the stone that would be caused by horses' feet. By the use of the tank wagon the tar was kept heated and under pressure, and this method of applying the tar greatly facilitated the work. The time required for one pouring over the entire section was about one-half hour.

Between 1 and 1¼ gals. of the tar was used in the first pouring for each square yard of surface. Screened stone, ranging from ½ in. to ¾ in. in size were then swept over the surface in sufficient quantity to fill the voids. The road was then rolled. After rolling from ⅓ to ¾ of a gallon of tar was spread over each square yard of surface, and the surface was again covered with the above-described screenings, a sufficient amount of screenings being used to cover the surface and protect the road while the tar was setting up. This was then thoroughly rolled, which completed the treatment of the section, and it was immediately opened for travel.

The cost of this section is as follows:

Crushed stone	$191.18
Labor on macadam	190.52
Tarvia "X"	133.20
Labor on top course	55.90
Total	$570.80

This material is manufactured by the Barrett Manufacturing Co.

In the present condition the stones are all well bound in this section, and no excess of tar appears on the surface.

Experiment No. 5—Tarvia "B."

This material is a tar preparation that may be applied without heating. In this instance it was placed on a macadam road that had been filled and rolled, but had not been watered, and had been under travel for about two weeks. In making the application, all of the

dust and dirt was carefully swept to the sides of the macadam, and on the clean surface the binding material, which had been heated for this work, was applied by means of the same tank wagon that was used for Tarvia "B." Two-thirds of a gallon was used per square yard. As soon as the Tarvia had been applied the dust that had been removed from the road was swept back over the surface.

This treatment is the most easily applied of any of the tar products that were used, and the results up to the present time have been very satisfactory. The surface of the road has kept in as good condition as any that was treated by the more expensive methods. It is not likely that the treatment will be as lasting as those in which the binding material was incorporated in the body of the stone.

The cost of this section is as follows:

Crushed stone	$191.18
Labor on macadam	242.52
Tarvia "B"	30.55
Labor applying Tarvia "B"	32.99
Total	$497.24

This material is manufactured by the Barrett Manufacturing Co.

This was the only bituminous surface treatment applied, and the result far surpasses our expectations. A thin coat of tar remains over the surface of the road. Its present appearance is fine and it has been more nearly dustless than any of the other tar or asphalt-treated sections.

Experiment No. 6—Liquid Asphalt.

The material used in this section is the Indian Refining Company's heavy asphalt binder, said to contain 90% asphalt. It was shipped in barrels and was heated for use on the road in a large heating tank. The barrels were rolled on skids to the top of the heating tank, and when in place one head of the barrel was knocked in and the material allowed to flow out of the barrel thus opened. Notwithstanding the fact that the weather was very warm while this work was being done, the material was so heavy that it flowed very slowly, and several minutes were required to empty a barrel in this manner. The material was heated to a temperature of about 200° F. and applied to the road under conditions similar to those used for the "Pioneer asphalt," described above.

The cost of this section is as follows:

Crushed stone	$191.18
Labor on macadam	190.52
Labor on top course	118.39
Total	$500.09

No charge was made by the manufacturer for the material.

This material is manufactured by the Indian Refining Co., of Cincinnati, Ohio.

On this section the stone forms the wearing surface, but it is all firmly bound in place. Its present condition is very similar to that of Experiment No. 3.

Experiment No. 7—Ugite.

The material used in this treatment is claimed by the manufacturers to be a true tar, made by treating water-gas tar in such a manner that the hydro-carbon compounds of the paraffins in the water-gas undergo a chemical change, resulting in the production of a true tar, without producing free carbon, which is commonly found in the coal-gas tars; consequently, a material that does not have the deep black color of the ordinary tar.

The preparation of the macadam for this section was similar to that for Experiment No. 3. The treatment was applied in two different ways, as follows:

At the beginning of the section, extending south for a distance of 273 ft., or a total of 485 sq. yds., after rolling in sufficient ¾-in. stone in the top course to bind it well, 2.05 gals. of the tar were poured on the road, at a temperature of 240°. The maximum air temperature during this work was 87°, the minimum 75° and the mean 81° F. The tar was heated in a small heating tank placed at the side of the road and the average rate of application on this part of the section was about 1,200 gals. per day. After pouring the tar on the road a small quantity of ¾-in. stone was then applied, just sufficient to keep the roller from the tar compound, and the surface was well rolled. Stone chips about one-half inch in size (France & Company, Dunkirk, Ohio) were then spread on and well rolled in. A light coating of ¼-in. screenings and dust (Woodruff & Pausch, Columbus, Ohio) was put on, to protect the road surface until the compound had a chance to set up. This was rolled until firm.

On the remainder of the section—127 ft. in length, or a total of 226 sq. yds.—the compound was applied in two coats. On the top course of stone, which had been filled previously with ¾-in. stone, well rolled in, 1.67 gals. per square yard was poured, at a temperature of 250° F. This was applied at the rate of 1,000 gals. per day. Sufficient ¾-in. stone was spread over the surface to keep the roller from sticking, and was well rolled in. A surface coating of .44 gals. per square yard, at a temperature of 280° F., was then put on at the rate of 3,000 gals. per day. One-half-inch chips (France & Company) were put on and well rolled in. This was followed by a light coating of ¾-in. screenings and dust, to protect the road surface while setting up. On this section, therefore, there was applied a total of 2.11 gals. of the compound per square yard.

The weather conditions during the construction of the second part of this section were slightly unfavorable, due to a shower at night which delayed the completion of the rolling of the section.

The cost of this section is as follows:

Crushed stone	$191.18
Labor on macadam	190.52
Ugite	92.40
Freight and transfer	58.12
Labor on top course	119.76
Total	$651.98

This material is manufactured by the United Gas Improvement Co., of Philadelphia, Pa.

In the construction of this section the binder was applied on part of the work in one coat and on the remainder in two coats, but at the present time no difference in its condition can be observed. The stone now furnishes the wearing surface; each piece is firmly bound and the condition of the section is very satisfactory.

Experiment No. 8—Fairfield Asphaltic Cement.

This material, which is described as a refined asphaltic cement, was applied to the top course of a two-course macadam road. This top course consisted of stone from 1½ to 3 ins. in size, in a layer 4 ins. thick, and it was thoroughly rolled before applying the asphalt, but without any screenings or other filler. The asphalt was heated in a small heating tank at the side of the road, and applied on the road by the use of buckets. The work was done about the first of August when the weather was extremely warm. The asphalt had been shipped in barrels, and it was so heavy and viscous that in order to remove it the barrels were cut in halves with axes, and on account of its adhering to the staves it was frequently necessary to throw them into the heating tank to save the material. After the asphalt had been applied, stone chips, varying in size from ½ to ¾ of an inch, were applied to the surface of the road to a depth of about one-half inch. This was then thoroughly rolled, the chips being forced into the voids of the macadam and also forming a surface over the top which prevented the asphalt from sticking to the roller. When this rolling was completed, the road was ready for public travel. Thirteen thousand three hundred and fifty pounds of the material were used in treating the section. The completed road remained remarkably firm during the warmest weather, and the horses' shoes made but slight impression on it.

The cost of this section is as follows:

Crushed stone	$191.18
Labor on macadam	190.52
Asphaltic cement	115.35
Freight and transfer	35.04
Charge on heater	5.00
Labor on top course	65.81
Total	$602.90

This material is manufactured by the Impervious Product Co., of Baltimore, Md.

At the present time this section is in perfect condition, with the surface very similar to that of Experiment No. 3.

Experiment No. 9—Asphaltoilene.

In the manufacturer's description of this material it is stated that it "is made from a heavy natural oil with an asphalt base and not containing paraffin. This natural oil contains so little of the illuminating oils or valuable products that it is not worth refining for their extraction. It is, therefore, never 'cracked' or coked, but contains a high percentage of liquid asphalt with sufficient oil to act as a solvent and vehicle."

This material was applied on a macadam road prepared after the manner of Experiment No. 8, excepting that the stone in the top course ranged in size from 1 to 2½ ins. The material was heated in a small heating tank placed at the side of the road and poured on the road with buckets. Twelve hundred gallons of asphaltoilene were used on this section, which was about 1.7 gals. per square yard.

After the asphaltoilene had been applied, one-half inch stone screenings and dust, in about equal parts, were spread over the surface of the road to a sufficient thickness to fill the voids and make a smooth and uniform surface, and the road was rolled until it was thoroughly consolidated and the asphaltoilene showed a tendency to stick to the wheels of the roller.

A few weeks after the completion of this section the oil appeared to rise from the body of the stone over a distance of about one hundred feet in length, and, combining with the dust that settled on the road, formed an excellent, smooth coating which was readily marked by horses' shoes. Over the remaining part of the surface the binding material did not rise to the top.

The cost of this section is as follows:

Crushed stone	$191.18
Labor an macadam	190.52
Asphaltoilene	116.32
Labor on top course	70.36
Total	$568.38

This material is manufactured by the Good Roads Improvement Co., of Cincinnati, Ohio.

At present about one-half of the surface of this section is covered with the binder, and on the remaining part the stone furnishes the wearing surface. Where the binder covers the surface of the road, the imprints of the horses' shoes show in a manner similar to that of a sheet asphalt pavement on an extremely warm day. The part thus covered is dustless and provides an ideal road surface.

Experiment No. 10—Wadsworth Macadam.

This material is Kentucky Rock Asphalt, very finely ground. It was applied on the top course of a macadam road, prepared after the manner of Experiment No. 9. About one inch of the asphalt was spread over the surface of the stone and evenly distributed with hand-rakes and then thoroughly rolled with a steam roller, forcing the asphalt into the spaces between the stones. This probably penetrated beneath the surface of the stone for an inch or more. After this had been thoroughly rolled, another layer of about one inch of the asphalt was spread, and this was again rolled thoroughly.

This material was applied in warm weather, but without artificial heat. When first completed the road tracked very readily; horses' feet and the wheels of vehicles marked it in such a manner that it seemed that it would soon be destroyed. After a few weeks of travel, however, the surface began to get firmer, and in a short time became very smooth. Several months after the completion of this work, it was as smooth as the best finished asphalt street, with no waves or cracks, and entirely free from dust.

This is an interesting construction, as it provides a surface very much like a sheet asphalt street, and can be constructed without artificially heating the material.

The cost of this section is as follows:

Crushed stone	$191.18
Labor on base	190.52
Kentucky rock asphalt	145.05
Freight	94.95
Lumber	10.29
Labor on top course	119.71
Total	$751.70

This material is manufactured by the Wadsworth Stone and Paving Co., Pittsburg, Pa.

This section is at the present time in as fine a condition as the best sheet asphalt pavement, and it is in better condition than when first constructed.

Experiment No. 11—Carbo-Via.

This material is a refined coal tar product. It was applied on a macadam road prepared after the manner of Experiment No. 9. The material was heated to a temperature of about 300° F., in the same tank that was used for Experiment No. 9, and was poured on the road with hand sprinkling cans. In making the first application about one and one-half gallons per square yard were poured. Immediately after the pouring the surface was rolled with a steam roller, the wheels of the roller having been oiled with an emulsion of kerosene and water, to prevent the carbo-via from adhering to the roller. After this rolling, a thin layer of stone chips was swept into the voids, and the surface was again rolled. About one-half gallon of carbo-via per square yard was then applied and rolled as before and covered to a depth of about three-fourths of an inch with stone screenings and dust. This large amount of covering has caused the section to remain quite dusty.

The cost of this section is as follows:

Crushed stone	$191.18
Labor on macadam	190.52
Carbo-Via	108.55
Labor on top course	78.70
Total	$568.95

This material is manufactured by the Continental Bitumen Co., Toledo, Ohio.

This section is at present in good condition, in appearance being very similar to Experiment No. 4.

Experiment No. 12—Concrete Macadam.

The construction of this section was practically the same as that of a water-bound macadam road, except that Portland cement was mixed with the screenings for the binder of the top course, with the expectation of increasing the cementing power of the stone dust. The cement was mixed with the dry screenings in the proportion of one part of cement to six parts of screenings. The mixing was done by hand on board platforms placed at the side of the road, the mixture being turned until it was of a uniform color. Upon the lower course of macadam, which had been shaped, rolled and thoroughly bonded, was spread a layer of limestone varying in size from 1½ to 3 ins., to a depth of about three inches. After this course had been thoroughly rolled, the above described filler was applied dry, using a spreading motion of the shovel, the rolling being continued during the process of filling until all of the voids were completely filled. Water was then applied and the rolling continued until a wave of grout was produced in front of the roller over the entire surface. This section was closed against travel and the surface was kept damp by repeated sprinklings for several days

after the work had been completed. Two months after completion this section had the appearance of a water-bound macadam and it was doubtful if the addition of the cement had been of any advantage. Fifteen barrels of cement were used in this experiment.

The cost of the section is as follows:

Crushed stone	191.22
Labor on base	226.12
Cement	17.10
Lumber	5.00
Labor on top course	42.00
Total	$481.44

This section at present has the appearance of a weather-bound macadam, and the addition of the cement to the binder has not produced any apparent benefit.

Experiment No. 13—Taroid.

Taroid is described by the manufacturers as being "a coal tar pitch prepared in liquidized form as a binder." The lower course, or base, for this section was shaped up with rather small size stone, filled and thoroughly rolled. The stone for the top course varied in size from 3½ to 1½ ins. This stone was spread to a depth of about three inches. The method of treatment was similar to Section No. 3. From 1 to 1½ gals. of hot taroid was poured on each square yard of surface. This pouring was done by hand; four-gallon galvanized pouring cans equipped with fan shaped nozzles being used. After the taroid had partly cooled, the surface was well rolled. Coarse torpedo sand was then spread over the entire surface and the road was again rolled, which completed the treatment.

The cost of this section was as follows:

Crushed stone	$191.18
Labor on base	174.02
Taroid	93.21
Freight and transfer	38.24
Labor on top course	86.05
Torpedo sand	14.00
Total	$596.70

This material is manufactured by the F. J. Lewis Co., Chicago, Ill.

The traveled surface of this section is at present in excellent condition. There seems to have been an excess of tar used as it has been bleeding at the sides until the surface of the ground is covered to a width of about two feet.

Experiment No. 14—Petrolithic Pavement.

This process of road treatment was introduced by the Petrolithic Pavement Company, of Los Angeles, Cal., who incorporate a heavy asphaltic oil into the road material by means of various tools and devices, some of which are patented by the company. The tamping roller is an important factor in the construction of this type of roadway. It consists of a roller about three feet in diameter whose surface is studded with iron teeth 9 ins. in length and having an end area of about four square inches. The action of these teeth on the road material is said to approximate that of a flock of sheep, and to produce a tamping, puddling and kneading action which compacts the lower portion first and gradually works the material into so compact a mass that the teeth or feet of the roller will finally ride on the surface without penetrating or indenting the roadway. The old macadam roadway where this section was constructed was first broken up with a rooter pulled by a steam roller and the loosening completed by turning with a common road plow pulled by horses. The loose stone was then smoothed with a heavy "A" harrow. The California liquid asphalt heated to a temperature of 200° Fahrenheit was then applied by means of a Petrolithic Glover Road Oiler. Three applications of one gallon each per square yard were made. The mass was then mixed by means of the petrolithic road cultivator and tamped and compacted by means of the petrolithic rolling tamper. A road grader was used to crown and shape the roadway. After the work of tamping had been completed, a small amount of limestone screening was applied and the surface smoothed with a steam roller. A fourth application of the asphalt consisting of about one-half gallon per square yard was used, the surface covered with limestone screenings and again rolled. This section presents a rather uneven surface at the present time, in some places the material seeming to have heaved or raised up. The cause of this has not yet been ascertained.

The analysis of this material by Chas. A. Blackmar, city oil inspector of Los Angeles, Cal., is as follows:

Test No. 3022. Sample No. 1. Tested, Date June 26, 1909. Kind of product, Residuum. Received, Date June 25, 1909. Source of supply, Whittier-Fullerton. Manufactured by Atlas Refinery.
Water 0%; B. S. 0%; Sediment .4%.
Volatility .2% to 220° Fahr.; 1% at 220° Fahr; Total .3%.
Organic matter insoluble in CCl ..... .22%
Inorganic or mineral matter CCl ..... .06%
Sulphur 1.45%
Asphalt 83.63%. Penetration 80° at 77° Fahr. D. of C. standard.

The cost of this section was as follows:

Crushed stone	$ 27.00
Asphalt oil	302.60
Labor	293.00
Total	$622.60

TABLE SHOWING THE DAILY TRAVEL ON NELSON AVENUE EXPERIMENTAL ROAD FROM JULY 31 TO AUGUST 13, 1910, BETWEEN THE HOURS OF 7 A. M. AND 8 P. M.

Days.	31	1	2	3	4	5	6	7	8	9	10	11	12	13	Total.
One-horse buggy	132	88	65	62	88	72	105	98	77	57	83	74	77	8	1,164
Two-horse carriage	2	3	2	1	3	1	1	2	...	...	3	...	1		20
One-horse wagon	16	46	58	46	43	39	83	11	45	57	63	48	50	7	679
Two-horse wagon	1	16	26	22	29	21	17	2	14	27	24	29	27	2	278
Runabout automobile	63	30	28	27	27	21	19	30	24	14	27	31	36	2	469
Touring car	70	55	59	45	66	45	53	83	61	14	44	65	70	4	770
Motor cycle	21	5	8	5	12	14	5	9	4	1	11	8	1		110
Horseback rider	6	1	1	4	2	...	2	...	3	2	6	...	9		39
Total	311	253	247	212	270	213	285	235	228	172	261	255	271	25	469

With the beginning of the warm weather this summer, the asphalt exuded on the surface of this section to such an extent that vehicles avoided it, traveling in the ditches on both sides of the road. Its condition became so objectionable and so many complaints were received that we were obliged to have it repaired. It was accordingly covered to a depth of about two inches with screened gravel ranging in size from ⅛ in. to 1 in., which was well rolled with a ten-ton macadam roller. The cost of this repair, exclusive of the rolling, was $50.15.

At the present time the road is rutted by the vehicles that pass over it. Outside of the line of ruts the gravel still covers the surface.

Experiment No. 15—Limestone Concrete

This section was constructed of concrete made of crushed limestone and Portland cement rolled in place with a steam roller. The foundation was prepared by grading and shaping the old macadam road to give it the cross-section desired for the surface of the finished work. It was well rolled before placing the concrete. The concrete was made in the proportion of one part cement, three parts screenings, ranging in size from one-half inch to dust, and six parts limestone from 1 to 3 ins. in size. The concrete was machine mixed. Water was used very sparingly on account of the impossibility of rolling wet concrete. It was difficult to secure a concrete mixer for this small amount of work, and the machine that was obtained was not of sufficient capacity to produce the quantity that would secure best results. Owing to the slowness of the work the roller was obliged to work over such short spaces that in part of the work a wavy surface resulted. If the work had been done more rapidly a much better surface would have been secured. The concrete was uniformly 6 ins. deep and had vertical joints across its width at several places. Two months after completion this section showed a very satisfactory surface, and it seems possible that work of acceptable nature could be made after this manner, if done under more favorable conditions.

The cost of this section is as follows:

Crushed stone	$197.63
Cement	180.60
Rent of concrete mixer	30.00
Lumber	8.90
Labor	251.56
Total	$668.69

A few places at the joining of different days' work in this section are at present beginning to show the effects of wear. About one-half of the section is in a very good condition, and it indicates that a satisfactory road could be produced by the methods used in its construction.

Experiment No. 16—Gravel Concrete.

This section was constructed as an experiment to determine the utility and economy of gravel concrete for construction of highways in localities where a good quality of bank gravel is found. The concrete used in this section was made from unscreened pit gravel and Portland cement in the proportion of one barrel of cement per cubic yard of concrete. The gravel was obtained from the Barnes Sand & Gravel Company, of Piketon, Ohio. This gravel cost 16 cts. per ton, f. o. b. cars at pit, and the freight rate was 50 cts. per ton, making the cost of gravel 66 cts. per ton on board cars at the siding about one-fourth mile distant from the work. The concrete, which was a wet mixture, was placed on the road 6 ins. thick and the surface was formed by dragging a template over it. This method of construction was used in order to secure a concrete at a low cost that would be uniform in quality from top to bottom with a surface that would not be slippery. The principal objection to rich concrete for paving has been its slipperiness. This work was made without joints and is in reality a slab 6 ins. thick, 16 ft. wide and 400 ft. long. It presents a smooth, hard, dustless surface, which gives indications of great durability. During the cold weather of December transverse cracks developed at irregular intervals due to the contraction of the concrete. No longitudinal cracks have developed.

The cost of this section was as follows:

Gravel	$113.81
Cement	149.19
Concrete mixer	30.00
Lumber	8.90
Labor	206.00
Total	$507.90

This section is at present in good condition and shows but very little signs of wear. The surface is sufficiently rough to afford a good footing for horses.

The transverse cracks that developed last winter do not up to this time show any greater wear than the other parts of the road, the cracks showing only as lines across the surface. This section is dustless, and it is one of the most interesting of these experiments.

Experiment No. 17—Water-Bound Macadam.

This section was constructed in accordance with the specifications for water-bound macadam now in use by the State Highway Department. The road is built in two courses, the methods employed on the two courses being identical. The stone ranges in size from 3 ins. to 1½ ins. The stone is first rolled dry until there is no longer any waving or creeping movement, and the voids are reduced to a minimum. Dry screenings varying in size from ½-in. to dust are then applied during the finishing process of dry rolling. When the voids are completely filled, water is freely applied and the rolling continued until a wave of limestone grout appears in front of the roller as it passes over the surface. After the surface has been treated in this manner it is allowed to dry out or set before traffic is permitted to pass over it.

The cost of this section is as follows:

Crushed limestone	$129.82
Labor	210.18
Total	$340.00

At present the automobile travel has removed all of the binder that was left on the surface of this section. The larger stones in the macadam provide the wearing surface. They are all perfectly bound and the condition of the road is satisfactory.

In order to provide a record of the wear on the different sections, levels were taken over the road soon after the completion of the work. The points at which the levels were taken were carefully located so that it is possible to ascertain the amount of wear by releveling at any time. Readings were taken on the center line, and at 4 ft. and 8 ft., both east and west of centers, at five stations on each section, making a total of 25 readings on each section of 400 ft.

The work was releveled in September of this year, and the result shows approximately a year's wear. The wear is shown in hundredths of a foot in the annexed table, and the amounts are the average at five points in each section.

A census of the travel was also taken from July 31st to August 13th, 1910, and a table showing the result is included.

TABLE SHOWING WEAR ON THE NELSON AVENUE EXPERIMENTAL ROAD ONE YEAR AFTER ITS CONSTRUCTION.

Section.	8 ft. east.	4 ft. east.	Center line.	4 ft. west.	8 ft. west.
1. Glutrin	.07 ft.	.07 ft.	.00 ft.	.00 ft.	.00 ft.
2. Standard Asphalt	.02 ft.	.07 ft.	.08 ft.	.08 ft.	.09 ft.
3. Pioneer Asphalt	.07 ft.	.07 ft.	.05 ft.	.03 ft.	.03 ft.
4. Tarvia "X"	.02 ft.	.04 ft.	.04 ft.	.05 ft.	.03 ft.
5. Tarvia "B"	.08 ft.	.04 ft.	.03 ft.	.00 ft.	.00 ft.
6. Indian Asphalt	.01 ft.	.03 ft.	.01 ft.	.03 ft.	.02 ft.
7. Ugite	.04 ft.	.05 ft.	.05 ft.	.03 ft.	.05 ft.
8. Fairfield Asphalt	.04 ft.	.04 ft.	.04 ft.	.05 ft.	.00 ft.
9. Asphaltoilene	.05 ft.	.04 ft.	.04 ft.	.05 ft.	.03 ft.
10. Rock Asphalt	.00 ft.	.00 ft.	.02 ft.	.03 ft.	.04 ft.
11. Carbo-Via	.03 ft.	.09 ft.	.07 ft.	.08 ft.	.07 ft.
12. Concrete Macadam	.04 ft.	.05 ft.	.05 ft.	.01 ft.	.00 ft.
13. Taroid	.02 ft.	.01 ft.	.03 ft.	.00 ft.	.00 ft.
14. Petrolithic	.03 ft.	.01 ft.	.06 ft.	.00 ft.	.00 ft.
15. Limestone Concrete	.04 ft.	.06 ft.	.02 ft.	.00 ft.	.00 ft.
16. Gravel Concrete	.00 ft.	.00 ft.	.00 ft.	.00 ft.	.01 ft.
17. Water-bound Macadam	.01 ft.	.03 ft.	.03 ft.	.01 ft.	.01 ft.

Besides the experiments described above the State Highway Commission is also interested in some tests of gravel roads in Darke County where six short sections of road varying in length 72 to 130 ft. have been constructed. Four of these sections have been built with various foundations of gravel with Tarvia "X" asphalt used as a binder. The other two sections have binders consisting of different proportions of clay filler and limestone dust.

These experiments have not as yet proceeded far enough to show any interesting results.

A Wooden-Apron Conveyor Carrying Miscellaneous Freight from Wharf to Warehouse.*

The cost of freight handling at terminals is at present entirely out of proportion to the low cost of transportation on modern ships, and railways. The opportunity for reducing it by the introduction of mechanical freight-handling systems has often been discussed in these columns. One of the problems which has generally to be met in handling freight at terminals is the transportation of miscellaneous freight from city wharves to warehouses on the opposite side of a wide and crowded thoroughfare.

The conveyor shown in the accompanying illustrations is performing this work satisfactorily at a wharf in Seattle, Ore. Besides making possible the more rapid unloading and reloading of ships without delays from congested traffic and blocked streets, it promises a very substantial reduction in the cost of these operations. The conveyor was built by the Jeffrey Manufacturing Co., of Columbus, O., from special designs made by the Pacific Engineering Co., of Seattle. It picks up cargoes unloaded on the Wall St. dock of Galbraith, Bacon & Co., and transfers them to the second floor of the warehouse, on the opposite side of Railroad St. In its passage across the street and the tracks of the Northern Pacific Ry., the conveyor is sheltered in a covered timber trussed bridge.

The bridge has two spans of 57 ft. and 95¾ ft. respectively and is supported at the juncture of the two spans by a single timber bent. The bridge floor is some 23 ft. above the street level. The sides are sheathed with galvanized iron. The roofing is of corrugated iron. The enclosed section of the bridge is about 8 x 8 ft. giving room for a board walk about 3 ft. wide beside the conveyor.

The conveyor's construction is quite plainly shown in Fig. 2. It is made up of transverse wooden flights attached to two roller conveyor chains. The flights are of Puget Sound fir and are each 3 ft. long, 1 ft. wide and 3 ins. thick. As assembled, they form a practically continuous apron 3 ft. wide. A 4 x 4-in. cleat made up of two 2 x 4-in. timbers is bolted to the face of every third flight. The flights are attached at each end to the rolling chains. Each chain link consists of two flat steel bars about 13 ins. long separated by the width of the rollers, one of which is mounted on each link-joint pin. The rollers run on rails made of 3 x 3 x 5/16-in.

At each end of the conveyor, the chains pass over sprocket wheels about 3 ft. in diameter. The conveyor is continuous and the return side runs on separate rails a foot or so below the carrying side. At the wharf end, as shown in Fig. 1, the sprocket is placed below the floor to facilitate the loading of the conveyor, which rises from the floor at this end at an angle of 20 or 25°. This angle is reduced by two successive bends so as to secure a more gradual transition to the horizontal stretch across the bridge. Thus the freight, in its passage through the dock house from the loading floor to the bridge entrance, follows a path somewhat approximate to a parabola. The sprocket shaft at the warehouse end of the conveyor is geared to a countershaft which in turn is belted to a 10-HP. electric motor. The conveyor is driven at a speed of about 60 ft. per min. Its total length from center to center of sprocket shafts is 250 ft.

*From information furnished by the Jeffrey Manufacturing Co., Columbus, Ohio.

Fig. 1. Wharf End.

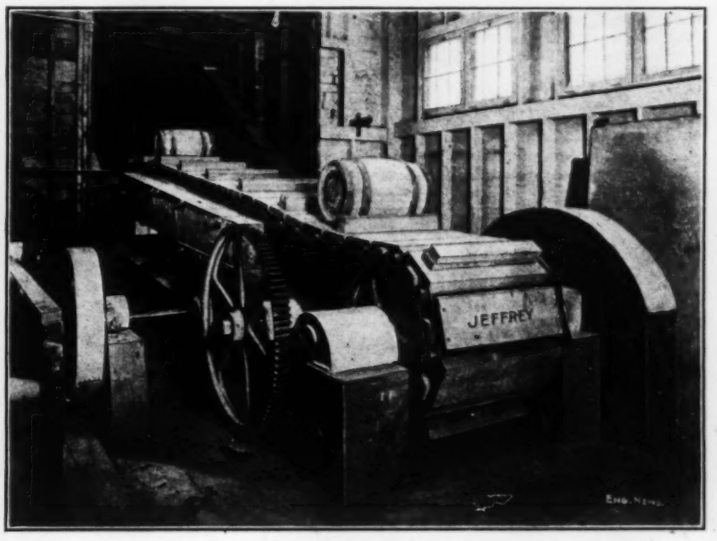


Fig. 2. Warehouse End.

FIGS. 1 AND 2. CONVEYOR HANDLING MISCELLANEOUS FREIGHT AT A SEATTLE WHARF.

MATERIALS HANDLED AND CAPACITY.—Package freight of any kind may be handled, such as baled hay, cement in barrels, packing boxes, etc. In addition, the practically continuous apron makes this conveyor available for transporting smaller miscellaneous freight such as loose brick, sacked sugar and pig iron. It is designed to carry safely 150 lbs. per running foot, or a single load of 2,000 lbs. concentrated at one point. The maximum capacity when handling material in barrels is 1,200 bbls. per hour; packed salmon, in cases weighing 70 lbs. each, can be handled at the rate of 1,200 cases per hour; when handling baled hay, the capacity is from 1,000 to 1,200 bales, weighing 120 lbs. each, per hour.

OPERATING RESULTS.—The photos reproduced herewith were taken at the time of unloading a cargo of cement. The ship was docked within 15 ft. of the receiving end of the conveyor. The barrels were placed in slings, six barrels to a load, and were hoisted from the hold by means of the ship's derrick. With the assistance of a portable electric hoist on the wharf, the sling loads were landed close to the foot of the conveyor. The wooden rails shown in the photo made it easy work to roll the barrels against the moving conveyor, where they were picked up by the cleats. In this way, over 3,000 barrels were readily handled in eight hours by a crew of 18 men. This included all the labor necessary for handling the barrels on the dock, receiving them at the warehouse end, chuting them to the lower floor and storing them.

The maximum saving which might be effected by the use of this conveyor can hardly be definitely estimated for the reason that it has not yet been tried out to its full capacity as material can not be brought to it from the ship rapidly enough with the existing facilities. A comparison can be made, however, with the methods formerly used for such a job as this cargo of cement. Under the old arrangement, transferring the material on trucks, 28 men paid at the rate of 27½ cts. per hr. were required for such a job. For an 8-hr. shift, the saving of ten men by the use of the conveyor would represent a money saving of $22. With three 8-hr. shifts per day, the conveyor would save daily $66. After making a very liberal allowance for cost of power and maintenance, the net saving will be well over $50 per 24-hr. day.

The total cost of the entire installation, including a new roof truss and other necessary alterations at dock and warehouse, amounted to about $6,745. Thus the saving per year, assuming the conveyor to be used 8 hrs. per day for 300 days, would amount to 75% or more, on the initial investment. It should be noted too that the cost of the bridge was much greater than necessary for the operation of the conveyor, since it was made large enough to give room also for a general passageway.

ILLINOIS MINE RESCUE STATIONS.—In February last, the Illinois Legislature provided for establishing three mine rescue stations, with complete equipment for the work of rescue following a mine disaster. We are informed by the Dean of the College of Engineering of the University of Illinois, Prof. W. F. M. Goss, that a station has been located at Benton, in the south coal field of the State; one is to be at Springfield, in the central field, and one at La Salle, in the northern district. Two men will be appointed for each station, one acting as general manager and the other as superintendent. Eight men who have recently passed preliminary examinations for these positions have been given special training at the Government Rescue Station at Urbana. The cost of such stations was noted in Engineering News, July 7, 1910.

SECURITY DEPOSITS of customers of gas and electric supply corporations, guaranteeing the payment of bills, are to be regulated by the Public Service Commission for the Second District of New York, a hearing having been held on Nov. 1 for the discussion of rules and regulations proposed. Among the proposed features of the regulative order are provisions (1) that interest at 6% shall be allowed on all deposits, (2) that certain specified forms for records and receipts shall be used, upon the reverse side of the latter being printed the terms and conditions on which the deposit is made, (3) that such receipts be substituted for ones now outstanding. It is stated that this action of the Commission is the result of a year's investigation into current practice, by which it was found that many companies allowed depositors less than legal interest and a few paid no interest at all; often no explanation was made as to why security was demanded, and no information was given as to consumers' rights; proper methods were not always kept of the deposits. Gas and electric supply concerns are given the right in New York to demand these security deposits by law, and it is stated that, in this district comprising all of New York except New York City, somewhere in the vicinity of 51,000 customers have been obliged to make these deposits to secure service. Deposit funds now in the possession of these utility corporations are reported to be about $468,000.

The Removal of the Debris of the Old Quebec Bridge.

By H. P. BORDEN,* Assoc. M. Can. Soc. C. E.

From the time the Old Quebec Bridge collapsed, on Aug. 29, 1907, up till January, 1910, the wreck of the structure has remained untouched, an object for most interesting investigation by the engineering profession, as well as an object of awe-inspiring interest to the thousands of visitors that flock to Quebec every season. With the beginning of the present year the work of removing the broken and twisted scrap was started, and during the ten months since then about half of the anchor-arm material has been cut apart and removed.

When the accident took place the south half of the bridge was practically completed. The anchor and cantilever arms had been erected, and only two more panels of the suspended span remained to be assembled. All of this portion of the bridge fell.† The wreck of the anchor arm was piled up in indescribable confusion between the anchor and main piers, being exposed at low tide. The cantilever arm and suspended span fell outside the main pier into deep water, and were entirely submerged, except for a distance of some fifty feet just outside of the main pier.

Before any work in connection with the construction of the masonry or superstructure of the new bridge could be started it was necessary that this fallen material be removed. The contract for clearing the site was awarded last December to Charles Koenig & Co., of Quebec, and since that date this firm has been constantly engaged on this work. At the present time about one-half of the contract has been completed, or in the neighborhood of 5,000 tons removed.

The magnitude and difficulties of the job cannot be appreciated unless one has personally visited the wreck and seen this enormous tangle of huge steel members piled high and in utter confusion, yet with no loose ends. Every ton of metal moved, whether eyebar, chord or post, must first be cut loose from its neighbor or subdivided into many pieces before it can be handled. The various members are twisted and bent almost beyond recognition, yet they are still firmly bound one to the other. Only one broken eyebar has been found in the whole wreck. Before these eyebars can be removed they must be broken or cut in two or three pieces. All the members radiating from a panel-point still have their connections intact at that point. A chord with possibly 1,000 sq. ins. of cross-section, and weighing 50 or 75 tons, must be broken or cut at either side of this panel-point and then cut into six or eight similar sections, to bring it within the capacity of the derricks. Most of the pieces removed in this way will still have to be broken up into even smaller sections before they have a marketable size as scrap.

METHODS OF CUTTING APART.—When tenders were called for the removal of this wreck, contractors, as a rule, were entirely at sea as regards the best way of cutting the material or as to the probable cost of such an operation. Both dynamite and the oxy-acetylene flame had been used on work of a similar nature, but for work of such enormous proportions there was absolutely no precedent. The work for the first month or two was, therefore, almost entirely experimental. Various grades and strengths of dynamite were tried, as well as gelignite, but it has been found that a 60 per cent. dynamite gave the most satisfactory results, everything considered. The oxy-acetylene flame has also been extensively used, and has shown some remarkable results.

The choice between dynamite and oxy-acetylene flame for cutting a member is governed very largely by local conditions. Practically all the eyebars are broken at the heads by dynamite, since the sticks could be placed between adjacent bars, thus obtaining the full force of the explosion. A number of the bars were also driven off the pins in this way, when there was little or no tension in the bars. A large panel-point or heavy pocket of metal can be first torn apart as much as possible with dynamite, the oxy-acetylene flame then being used to free the ends of a member or generally to complete the work left unfinished by the dynamite.

OXY-ACETYLENE CUTTING. — Where the oxy-acetylene flame has been used to greatest advantage is in cutting up the heavy chords and posts into pieces that can be handled by the derricks, which have a capacity of not over ten tons. The webs are first separated by cutting the lattice-bars or cover-plates. The webs themselves are then cut longitudinally, as well as vertically. One web 4 ft. 6 ins. deep, with a section of 190 sq. ins., was cut in 20½ mins. with a consumption of 112 cu. ft. of gas. In cutting eyebars it was found that, with a stream of pure oxygen gas, one square inch of metal could be cut on an average of 5⅝ secs., with a consumption of 0.4 cu. ft. of gas, at a cost of 1.2 cts. for the oxygen gas.

The oxy-acetylene torch cuts the steel very rapidly, and leaves a thin, sharply defined slot, not wider than that made by a saw. The torch itself weighs only a few pounds, and, as a consequence, can be used in any point, no matter how inaccessible, so long as it can be reached by the operator.

The acetylene gas is manufactured on the site, and is led to the torch through a ½-in. hose pipe, under a pressure of 10 lbs. per sq. in. The oxygen gas is delivered in steel cylinders, each containing about 100 cu. ft., under a pressure of 1,800 lbs. The gas is led to the torch through a ¼-in. flexible steel tube under a pressure of about 10 lbs. per sq. in. The oxy-acetylene plant is supplied by The Linde British Refrigeration Co., Ltd., of Montreal.

Since the beginning of operations some 50,000 cu. ft. of gas have been consumed, or an average of 10 cu. ft. per ton of material removed.

DYNAMITE CUTTING.—The heavy part of the work is done with dynamite. Panel-points and other points of intersection sometimes require many very heavy charges before they can be reduced to the size required for handling. Charges as high as 80 lbs. were used in tearing apart the heavy shoes on the main piers. Some of these heavy explosions have thrown pieces of metal weighing eight or ten pounds entirely across the river, a distance of nearly half a mile. Dynamite has also been used to advantage in cutting, especially where the metal is not too thick. It has been found that one stick of dynamite will break a plate ½-in. in thickness. Two sticks will break a plate 1-in. thick. Therefore, a row of sticks of dynamite in this proportion will give practically the same results as the flame. To facilitate handling, the sticks are encased in a rubber tube or wrapped in cloth before being placed in position. In this way they may be securely fastened in positions which would be impossible otherwise. If possible the charge is covered with earth or other material before firing, in order to obtain the fullest results from the explosions. The best results are obtained when fired under water.

Up to the present time some 12 tons of dynamite have been used, or an average of about 5 lbs. per ton of material removed.

For the present the scrap is being stored on the shore, just east of the bridge, and clear of the right-of-way. The material is the property of the contractor. He has already shipped several barge loads to Montreal, and will be able to dispose of the entire quantity at a good price.

FIG. 1. THE WRECKAGE OF THE SOUTH ANCHOR ARM OF THE QUEBEC BRIDGE.

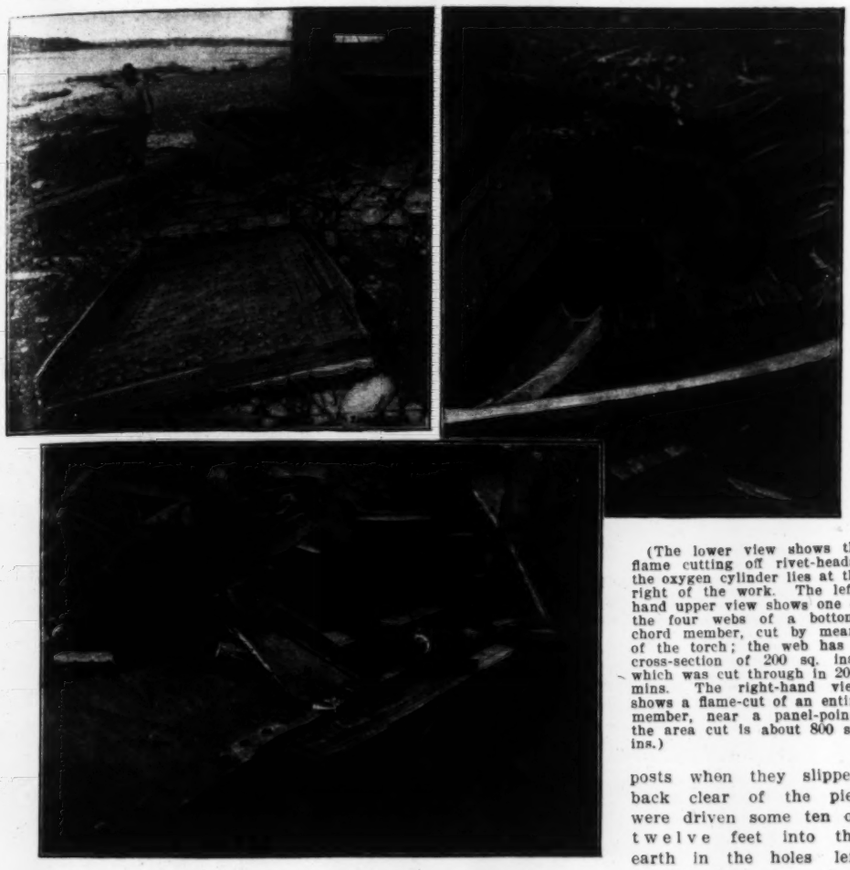
(View looking north toward South Main Pier. From a photograph taken a few days after the collapse of Aug. 29, 1907. The wreckage remained thus untouched till Jan. 1, 1910.)

FIG. 2. VIEW NEAR SOUTH PIER, SHOWING PROGRESS IN REMOVING WRECKAGE.

(Work began Jan. 1, 1910. The view shows the results of about nine months' work. Clearing had to begin near the pier to permit early start of work on the new caissons and pier.)

*Assistant Engineer, Board of Engineers, Quebec Bridge; Montreal, P. Q.

†See Engineering News of Sept. 5, 1907.



(The lower view shows the flame cutting off rivet-heads; the oxygen cylinder lies at the right of the work. The left-hand upper view shows one of the four webs of a bottom-chord member, cut by means of the torch; the web has a cross-section of 200 sq. ins., which was cut through in 20½ mins. The right-hand view shows a flame-cut of an entire member, near a panel-point; the area cut is about 800 sq. ins.)

FIGS. 3-5. QUEBEC BRIDGE WRECKAGE: OXY-ACETYLENE FLAME CUTTING.

While the contractor has made remarkably good progress up to date, yet he has been working under a considerable disadvantage. The natural program of work would have been to start on the top or on the sides of the pile, where both ends of the majority of the members could be seen and readily got at. In order, however, to prepare for the reconstruction of the new masonry, it was necessary that the material be first cleared from the vicinity of the main pier. As a consequence the contractor had practically to start in the middle and work each way, which has increased his difficulties to no small extent.

These difficulties have been further increased by the fact that the ends of the main center posts when they slipped back clear of the pier were driven some ten or twelve feet into the earth in the holes left by the false-work piers. The holes being filled with water at low tide has made the removal of this panel-point very difficult. The contractor has been working for over three months, and has finally succeeded in clearing the west hole. The east hole still contains some ten or twenty tons, but it is expected that this will be cleared out within the next week or two.

The most difficult part of the work, probably, is the removal of the steel that has fallen outside of the main pier. All this material lies in deep water, parts of which extend some twenty feet out of water at low tide. According to the contract the steel has to be taken down below low-water level. Continuous efforts have been made during the past two months to shatter this steel with dynamite, but as yet little progress has been made.

It was required that the steel on the main pier and 100 ft. south of the main pier should be removed by September, 1910. This part of the work has been completed. The remainder of the steel must be removed by May 1, 1911.

Fig. 6. Quebec Bridge Wreckage: View Showing Sticks of Dynamite Grouped in Rows and Bundles for Use in Cutting Steel Members.

FIG. 7. VIEW SHOWING RESULT OF BLASTING THE 80-TON MAIN SHOES ON THE SOUTH PIER.

Iron Hoops for Wooden Water Tanks.*

FLAT HOOPS.—Until recently flat hoops were used almost universally. Many advocate this style as the best, claiming that the hoops have a more uniform bearing on the staves, do not crush the fiber of the wood, and if properly put on and cared for will outlast the staves.

The experience of others has been to the contrary. Flat hoops have been removed after a comparatively short service, badly corroded on the inside and with the staves badly decayed under the hoops. Location of the tank is a factor in the life of a hoop. At a terminal, perhaps next to an engine-house or a clinker pit, the hoops will deteriorate rapidly. There are instances in which the water in the tank is especially injurious to the hoops, and location near salt water is also a severe test. In thickness they run from ⅛-in. to ⅜-in. and in width from 3 to 6 ins. Some roads use a uniform thickness and vary the width, some use a uniform width and vary the thickness, while others use various widths and thicknesses. Steel hoops are found to be brittle, and often break while being tightened, or as the result of the swelling of the tank, or on account of unusual weather conditions. The most serious objection is that they corrode more easily than wrought iron. Galvanizing lengthens their life, but does not eliminate the brittleness, and many claim that the galvanizing covers surface defects that would otherwise cause the rejection of the material. Galvanized hoops should be inspected before and after galvanizing.

ROUND HOOPS.—Round hoops have come into use only within the last few years and seem to be proving very satisfactory. Wrought iron is considered the best material and is more easily obtained in this form than in the flat shape. Mild steel is sometimes used, but has the objection of brittleness.

One argument in favor of the round hoop is that fully 90% of its surface is exposed to view; deterioration is more easily discovered and painting is more effective. With the flat hoop, at least 40% of its surface is next to the staves and practically inaccessible. It is claimed that because the round hoop has less bearing surface on the stave it crushes into the fiber and not only weakens the stave, but induces decay. Others who have had experience say that if the hoop is properly put on there is no appreciable crushing of the fiber.

The round hoop forms a ledge or pocket on the upper side which allows the accumulation of dirt, cinders and moisture. Some claim that this is not a serious matter because the sun and wind evaporate the moisture before harm can result. The Wheeling & Lake Erie Ry. calks the round hoops with oakum and fills the top space with roof cement to shed water and also to protect the hoops.

SQUARE HOOPS.—The committee received no report from any railway using square hoops as a standard. The Illinois Central Ry. has one tank equipped with hoops ¾ x 2 ins., which may be called square hoops for all practical purposes. These have been in service for about 20 years, and show no great sign of deterioration. In parts of Mississippi there are many wooden tanks with hoops from 1⅛ ins. to ¾-in. square, put on in three sections.

SEGMENTAL HOOPS.—The segmental hoop has one flat side and does away with the objection to the round hoop of crushing into the wood and of collecting and holding dirt and moisture. It has all the advantages of the flat hoop, with the added one of being narrower for the same length; and, because it is heavier at the center it is not weakened so quickly by corrosion. The material is a standard shape that is carried in stock.

In tanks 20 to 30 ft. diameter it is usual to have the hoops in three sections; some railways use four and others use two sections. The two-section hoop is difficult to erect, and by using more sections the stress on the staves can be more uniformly distributed.

*Brief abstract of a committee report presented at the annual meeting of the American Railway Bridge and Building Association at Denver, Colo., in September.

Driving Spiral Tunnels on the Canadian Pacific Ry.

One of the most interesting of the many grade reduction works that have been undertaken by railways on this continent is that of the Canadian Pacific Ry. between Field and Hector, B. C., in the valley of the Kicking Horse River. The original distance was four miles, with a grade of 4.5% (compensated) for about three miles, and

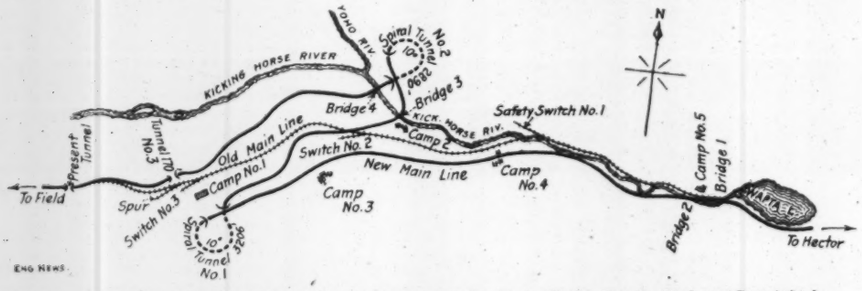


FIG. 1. MAP OF GRADE REDUCTION WORK (SHOWING THE TWO SPIRAL TUNNELS) BETWEEN FIELD AND HECTOR, B. C.; CANADIAN PACIFIC RY.

3.5 to 4% for the remainder of the distance. For safety, three spring switches or catch sidings were introduced, which were normally closed to divert a train onto the spur and opened only when the engineman of a descending train signaled to the switchman that his train was under control

Owing to the increase in traffic and in train loads it became very desirable to eliminate these extreme grades, but it was a difficult matter to find room for the necessary development of length along the steep sides of this valley. The location finally adopted forms three lines in the valley, connected by loops, and the only way in which these loops could be made was by means of tunnels in the mountain side. The grade is reduced to 2.2% (compensated) and the length is increased to 8.2 miles. The compensation for curvature is 0.04% per degree, but this is increased to 0.06% in the tunnels on account of the liability of damp rails reducing the adhesion.

The general character of this work was described in our issues of Jan. 23 and March 19, 1908. It was shown that while on the old line it required four 154-ton consolidation (2-8-0) engines to haul a train load of 710 tons up the grade, it was estimated that one of these engines would handle 980 tons on the new line.

Fig. 1 shows the old and new location, together with the positions of the tunnels, bridges, construction camps, etc. The contract for this stretch of grade reduction work was awarded to Macdonell, Gzowski & Co., of Vancouver, B. C. Their work included the grading of 8.25 miles of line, two spiral tunnels, one short straight tunnel (710 ft.), and four bridges over the Kicking Horse River. The grading was the average heavy rock work. Fig. 3 shows one of the cuts in solid rock, the material being handled out by stone boats on a log track.

The most interesting work was the driving of the spiral tunnels. These are on loop curves of 10° (or 573 ft. radius), with a grade (as reduced by compensation) of 1.6%. Tunnel No. 1 is 3,200 ft. long, and turns an angle of about 234°; the difference in elevation of its portals is about 48 ft. Tunnel No. 2 is 2,890 ft. long, turning an angle of about 232°, and having a difference in elevation of about 45 ft. at the two portals. Figs. 2 and 5 show both portals of tunnels Nos. 1 and 2. Fig. 4 is a cross section of the tunnels.

For the following information as to the details of the construction work on the two spiral tunnels we are indebted to Mr. C. S. Gzowski, of the contracting firm.

There was a camp and plant for each tunnel, and the equipment for each plant was practically the same. Table No. 1 shows the principal equipment of the plant for both tunnels. The location of the plant for camp No. 1 was put on the old line about 250 ft. in elevation below the portal of tunnel No. 1 and about 800 ft. distant from it. The plant was located at this point as there was a small bench on the mountain side which enabled the machinery for the compressor, etc., to be handled conveniently from the old railway line. Another reason was that water for operating the plant was obtainable there by digging wells and catching the seepage.

The plant at camp No. 2 was located on the Kicking Horse River about ¼-mile beyond tunnel No. 2 and on about the same level as that tunnel, or 150 ft. below the old railway line. The plant for this camp was unloaded off the old line and let down a skidway to its location.

The first operation, that of excavating both portals of each tunnel was conducted by hand labor, while the machinery at each camp was being installed. By the original plan of operation it was intended to use compressed air drills and do the mucking by hand from a "jumbo" car. After a short trial of this method it was decided to use power shovels (operated by compressed air) at each working end of both tunnels. This necessitated doubling the capacity of the air compressors as well as the boiler capacity.

Method of Tunnel Driving.

The driving of the tunnels was through crystallized limestone, very much distorted, and in places (where badly crushed) timbering had to be used. About 25% of the length of each tunnel was permanently timbered and enlarged to a sufficient size to allow of a concrete lining being put inside at some future time. In fact, in the untimbered portion, after the character of the ground had been well determined, it was decided to enlarge this also, to permit of a future concrete lining.

The method of driving the rock section which did not require timberng, was to drive a full top heading, keeping it about 10 or 12 ft. ahead of the bench (which was kept as vertical as possible), and to shoot the heading and bench at the same time. After a shot was completed, the drillers mucked back from the heading sufficient to set up their drill columns, and then set up and started the drilling. In the meantime, the shovel (run by air) was moved up and started mucking out the last shot. This shovel gang would get cleaned up about the time the drillers had the heading drilled and the down holes of the bench finished. The shovel was then moved back about 150 ft. The drillers then drilled lifter holes in the bench.

When all the drilling was finished, the drills, hose lines and fittings were all moved back. While this was being done, the cut holes in the heading were being loaded for springing. These cut holes were sprung and then fired. Then the side rounds and lifters of the heading, as well as all the bench holes, were shot at one time.

This method of keeping the bench close up to the heading allowed the greater part of the muck of each shot of the heading to be thrown back with the bench muck, which was removed directly by the shovel. Where the timbering had to be carried as the heading was driven, the bench was left about 50 ft. back. The heading was shot and then mucked by hand, the material being carried to the bench in cars and then dumped. The permanent timber plates were put in and each segment trimmed off, and then lagged and wedged up.

The bench was always kept as vertical as possible. Before shooting the bench, the wall plate was well supported by blocking up, and the last full-length post protected by old timbers. Just enough bench was shot in each round to allow another full post to be put in, and then this muck together with the muck coming from the heading was cleaned up with the power shovel.

DRILLING.—The arrangement of the drill holes was varied somewhat from time to time as the character of the ground changed. The stratification of the rock as encountered in the different parts of the tunnels varied from nearly horizontal (sometimes dipping up, down or to one side) to practically vertical and parallel to the direction of the tunnel. The formation of the ground at No. 1 tunnel was somewhat uniform, in regard to its stratification, lying with a plane dipping about 20° to the northeast, but as the tunnel made the best part of a circle this was encountered at all angles in the face. The stratification of the ground at No. 2 tunnel had not

FIG. 2. UPPER AND LOWER PORTALS OF SPIRAL TUNNEL NO. 1.

the same general uniformity as that on the other side of the valley. The hardness of the rock, the distortion and other conditions changed every few feet.

The general plan of the drill holes in the heading was to put in two rows of cut holes about 12 ft. deep and sloped so as to nearly meet. The

Fig. 3. A Solid Rock Cut (Debris Being Removed by Stone Boats On a Log Track).

side holes and lifters were about 10 ft. deep. The distance of the side holes from the tunnel line was judged by the character of the ground. These were varied as much as 2 ft. in line. The bench had a row of down holes on the top, about 8 ft. back from the edge and about 10 ft. deep; also a row of lifter holes in from the bottom of the face, 12 ft. deep, so pointed as to go 1 ft. below grade. The aim was to break 8 ft. of heading and the same amount of bench each round. It was found necessary to change the number of holes very largely as the rock changed. In tight ground the round of the heading would not break back within sometimes 2 ft. or more of the bottom of the holes, while in other ground it might go practically to the bottom.

The rock was of such character that the drilling throughout almost the entire length of both tunnels was most difficult. The formation being crystallized, it was brittle; and having been distorted by upheaval it was in a semi-fractured state. This condition made small wedge-shaped pieces break off in the holes behind the bits of the drills and jam them. Various shaped drill bits were tried, but none overcame the difficulty. The old trick of throwing small bits of iron into the hole was the most effective. The progress of the work was very considerably retarded by the bad conditions for drilling, and although the number of drills was increased to as many as space would permit of working the desired progress was never attained.

MUCKING.—The shovels were the standard No. 20 Marion shovels, with special short booms and dipper arms, and rock dippers with "Panama" teeth. The compressed air was delivered into the boiler, which acted as an additional receiver. The shovels were set as close to one side of the tunnel as possible and had each a special short jack arm to support it on the inner side. There were four shovels, one in each end of both tunnels.

A track of 2-ft. gage was used for the cars, and a double track was run in the whole length of the tunnel to a switch, which was kept close up to the shovel. The empty cars came in on one track and the loaded cars went out on the other. The cars were built on the ground and held about 4 cu. yds. One car was switched alongside the shovel and loaded, then run out and replaced by another. It took only about one minute for a loaded car to be run out and another empty switched in place, as the switch was kept as close as possible to the shovel.

The tunnels being on a continuous grade, one end was being driven up grade and the other end down. Where driving down grade, the loaded cars were hauled out by horses and ran back by gravity. Where driving up grade, the loaded cars ran out by gravity (manned by brakemen), and were hauled back by horses.

WATER.—In each tunnel there was considerable water from seepage through the crevices, and small springs were struck in different places. With the ends being driven up grade there was no difficulty, as a ditch at the side of the tunnel took care of this water. In the end going down grade, all the water naturally drained towards the face of the tunnel. To take care of this, a sump hole about 3 ft. square and 3 ft. deep was put in a few feet back from the face. A pump operated by compressed air kept the water down in the sump hole, discharging out of the tunnel through a 4-in. wooden pipe. A new sump hole was put in from time to time as the face of the tunnel progressed, and occasionally the pump was moved forward as the lift got too great for the suction end.

If anything went wrong with the pump for a short time the tunnel would fill up very rapidly with water. In order to avoid the delay due to this, a second pump was installed, making a duplicate system, so that if anything went wrong with one pump the other could be turned on by merely opening the valves. In the winter considerable trouble was experienced with the discharge pipe freezing near the outlet end in the tunnel. This was overcome by covering the pipe with manure.

ELEVATION.—The elevation at the work being about 5,000 ft. above sea level, a certain allowance had to be made in figuring the steam and compressed air plant. A gain was made in generating steam and on the exhaust end of the steam, but there was a loss on the compression of the air and a gain on the exhaust of the air drills and other machines.

WEATHER.—During very cold weather, considerable difficulty was experienced with the freezing up of the air supply pipe lines from the compressor houses to the tunnels. This was due, of course, to the freezing of the moisture condensed from the compressed air. Where the pipes leading away from the compressors were going up a considerable grade there was no trouble experienced, because the moisture condensing out of the compressed air would run back to a warmer part of the pipe. Where the pipes were nearly level or running down grade, they were continually freezing in different places during the very severe snaps. Additional air receivers were put on the air lines close to the compressors to further cool off the air and further condense out the moisture and also small blow-off cocks put at intervals along the pipe. These methods somewhat reduced the freezing trouble, but did not altogether overcome it.

METHOD OF GIVING LINE AND GRADE.—A base line was established between the two portals, which intersected with the tangents (or tangents produced) of the curves on which the tunnel was driven. From this base line all alinement was given by setting out calculated deflections and distances. As a proof of the correctness of these calculations, previous to starting the work these lines were run out on the

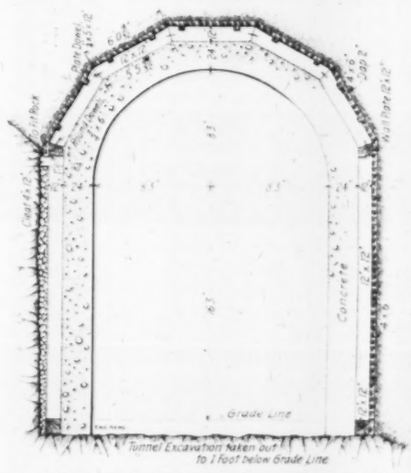


Fig. 4. Cross-Section of the Spiral Tunnels, Showing the Timbering As Arranged to Give Room for a Concrete Lining.

prairie and they checked practically exactly. Centers were given from time to time in the tunnels, 20 ft. centers as a rule. A table of offsets from the production of these short chords was given the foreman, who was thus able to get his center at any time from the last two centers. The centers were marked in the roof as well as on the bottom. The levels, of course, did not need any particular plan of action, being carried as in ordinary work, but with great care.

The final result when the headings met was practically exact, the alinements closing within ¾-in. and the grade within a few hundredths.

PROGRESS RECORDS.—Table II. shows the monthly progress at each tunnel. At first sight the record does not appear to be very good. As a matter of fact, however, it is considered to show very good progress under the adverse conditions due to difficulties in the drilling, troubles with water, the timbering and the very cold weather in winter.

FIG. 5. UPPER AND LOWER PORTALS OF SPIRAL TUNNEL NO. 2.

TABLE I.—PLANT FOR DRIVING THE SPIRAL TUNNELS; CANADIAN-PACIFIC RY.

1 American-Rand cross-compound air-compressor capacity, 1,050 cu. ft. of free air per min. Air cylinder 22 and 13 × 16 ins.; steam cylinders, 14 and 24 × 16 ins.
1 Ingersoll-Rand straight-line air compressor; 1,100 cu. ft. per min. Cylinders, 20 and 20 × 30 ins.
1 Ingersoll-Sergeant straight-line air compressor; 1,425 cu. ft. per min. Cylinders 24 and 26¼ × 30 ins.
8 Fairbanks-Morse duplex pumps; 6 × 4 × 6 ins. to 8

× 5 × 12 ins.; 6 ram pattern, 2 piston plunger pattern, 5½ × 3½ × 5 ins.
1 Atlantic pump 7 × 4½ × 6 ins.
9 boilers; 2 return tubular, 100-HP.; 4 Jencks locomotive type, 80 HP.; 2 locomotive type, 100 HP.; 1 Brady-Mumphard, 100 HP.
2 Comstock Climax engines: (1) 7 × 10 ins., 25 HP.; (1) 4 × 5 ins.
1 Little Giant hoist; cylinders, 5 × 7 ins.
1 American hoisting engine with boiler; 25 HP.; cylinders, 7 × 10 ins.
1 General Electric d. c. generator, 25 KW., 250-volt, 100 amperes.
2 Westinghouse d. c. compound-wound generators, 6 KW., 125-volt, 48 amperes.
4 Marion steam shovels (operated by compressed air).
22 Canadian-Rand Little Giant rock drills.
6 Ingersoll-Sergeant rock drills.

TABLE II.—RECORD OF PROGRESS ON SPIRAL TUNNELS AT FIELD, B. C.; CANADIAN PACIFIC RY.

Month.	Tunnel No. 1.	Tunnel No. 2.
1908.	Ft.	Ft.
Jan.	34 started one end.	..
Feb.	108 started other end.	35 started one end.
Mar.	208	111 only one end.
Apr.	226	122 started other end.
May	277	157
June	244	118 trouble with water
July	180 trouble with	133 and bad ground.
Aug.	158 smoke and wa-	107
Sept.	173 ter.	219
Oct.	165	301
Nov.	158	277
Dec.	200	252
1909.		
Jan.	156 trouble with frost	244 trouble with frost.
Feb.	150	215
Mar.	215	251
Apr.	197	287
May	170 finishing	63
June	75	..
	3,184 ft.	2,912 ft.

Protecting Embankments and Restoring Them When Washed Out.*

If a sufficient number of openings were left in embankments, railways would not be so liable to washouts. In many instances serious washouts occur because ordinary trestles have been built where there should have been larger clear waterways. In trestles the piles may be well driven, but should there come an accumulation of drift, the earth may be scoured from around the piling and the bridge washed away, or a washout may occur at the approach of the trestle or other point.

When several panels of a trestle are washed out and it is desired to pass trains quickly, a good plan is to point piles and work them into the soil with cant hooks. When all the piles have been set and braced, place sash near the grade and jack them in. After all of the bents have been placed in this manner, with the track standing sufficiently high to allow for settling, run empty cars over the structure to settle it, and then block up. Then run over the loads, after which allow the engines to cross, but the first engine should not move slower than ten miles per hour.

It is again often the case that culverts (sufficiently large to carry the water) become choked with drift and the fill is blown out. Such danger can be obviated by making the opening larger. We, of course, realize the importance of removing or burning any brush or obstruction at or near culverts or trestle as often as such accumulations occur.

We will now consider the case where high water has washed out the roadbed, and the track has been carried from the fill. Where the fill is low and the track is not turned over, it can readily be lined back to its original bed without taking it apart; but if the track is turned over it is cheaper to first remove the ties. In that event have the ties placed on the roadbed and the rail moved to one side by lifting it with a large force and dropping it upon the ties without uncoupling. The most difficult problem in such a case is in separating the ties from the rails. A good plan is to cut poles 10 to 12 ft. long, and use them as levers, pry off the ties.

It frequently occurs when the roadbed is badly washed that water is encountered too deep to crib, but temporary bents may be placed in such holes to advantage. This difficulty occurs particularly where there is a large river to contend with.

Should the water carry the track from the roadbed and it lodge against trees it should be floated back to its original bed while the water is up, if possible. It may be pulled in by a hand crab or with an engine.

Where the overflow occurs frequently, the track should be raised above the danger line. Until this can be done the trestle should be securely anchored and the track ballasted with heavy stone or slag. If it is not possible to secure either kind of ballast, a Bermuda sod is very good. The track also should be anchored at such points. This can be done by driving piles on alternate sides 30 ft. apart. A cheap and effective way is to bore holes near the ends of the ties (on alternate sides) 30 ft. apart, and drive a 1¼-in. bolt into the roadbed, leaving the nut on the upper side. The work of driving can be done from a push car.

*Abstract of a committee report presented at the annual meeting of the American Railway Bridge and Building Association, at Denver, Colo., Oct. 18, 20.

Where bad washouts have occurred and much cribbing has to be done, a steam derrick is one of the handiest tools obtainable for loading timber and placing it on the roadbed, particularly so if the timbers are long and heavy.

A wash or slide may occur at the side of a fill or near the mouth of an opening. Such trouble is frequently due to the manner in which water is permitted to strike the opening, and it can frequently be obviated by changing the current. Should it not be practicable to change the water course where it runs parallel with the roadbed it may be riprapped with heavy stone. In such a case it is a good plan to dig a good foundation 2 ft. below the surface, begin the wall in the ditch and run it up at a slope of 2 to 1. The bottom of the ditch or channel should be floored with heavy stone. Such construction will frequently answer the purpose of a concrete wall and can be built much cheaper. A wall should be used at the ends of all trestles that are subject to wash.

In cases where slides have occurred, caused by the current undermining the roadbed, and rock cannot be secured, it is advisable to drive piling at the lower edge of the fill and begin a wall of timber well under ground. Timbers 12 × 12 ins. should be placed on the side of the piling nearest the track. This construction will hold securely until the timber decays.

If the earth is of prairie formation it is subject to cracking during dry weather, and when the rains begin the water is absorbed by the cracks. If the fill is inclined to slide, from any cause, it is more liable to do so after heavy or continuous rainfall. This can be prevented by ballasting and spreading the ballast to the slope from the ends of the ties to the outer edge of the fill. A spread of 4 to 6 ins. to retain the moisture is required. Clay or soil of a sandy nature will answer when ballast cannot be obtained.

If the fill is of a sandy nature the entire embankment is inclined to wash, but if 4 ins. of cinders be placed on the fill to the edge of the slope, on either side of the ties, the bank will not wash at all on top and not so bad on the sides. The falling water, being absorbed by the cinders does not flow down the sides of fills with such force.

Where heavy drifts of debris accumulate against a trestle or piers a derrick car with a wrecking crew can be used advantageously; in fact much more satisfactorily than an engine with block and fall. In removing drift to relieve a structure it is sometimes advisable to use dynamite. Where heavy washing or scouring is being done by the currents and rock is not available, use bags of sand freely, as they can frequently prevent bad breaks in the roadbed.

There are cases where nothing in the way of a temporary trestle would be advisable, and piles must be driven with extension drivers from both directions. Where there is no water to interfere, frame bents should be erected in addition to driving piles; but if plenty of 12 × 12-in. timber and cross ties are at hand cribbing can be used to advantage. The foundation for cribbing should be built of 12 × 12-in. timbers or stringers, and placed so as not to interfere with the driving of piles after the traffic has been resumed. This can be quickly and effectively done by building pens. Bents can then be driven between the pens. Again, if there is a sufficiency of long timbers use them after getting the foundation timbers in. This can be done quickly, particularly if the timbers are handled with a derrick car.

When a bridge is found to be settling due to scour under a pier it is necessary to drive a bent on either side of the pier as quickly as possible. After getting two bents in on either side and the bridge seated on the timbers and bolted, the trains can be passed with safety until the pier is reset. If it be not possible to drive piles, place false bents until the settling can be stopped, after which drive the piling. Sand bags or stone dropped around the pier frequently prove beneficial.

Should a wash or slide occur on one side of the roadbed, where the bank is still good on the opposite side, and the track cannot be lined over far enough to carry the trains, drive piles 8 ft. apart near the rail and place a 12 × 12-in. timber on the piles longitudinally under the rail, to support the track.

The New Orleans & Northeastern Ry. has used rows of piles for protecting the embankment along the shore of Lake Pontchartrain against storm waves from the lake. The piles vary in length from 26 to 40 ft., depending on the depth of the water. They are driven about 16 ins. centers and on a line 100 ft. from center of the main track. Spacing the piles 16 ins. centers allows 4 to 6 ins between the piles. The storms beat more or less sand and shells between the piles and material filling has resulted. In addition, the space allows the waves to break, and part to go through, whereas a solid wall would cause the waves to fall back and undermine. The piles are cut off 8 ft. above low water.

Considerable trouble has been experienced with sliding embankments of the Yazoo Canal along the tracks of the Alabama & Vicksburg Ry., at Vicksburg, Miss., prior to 1876. This embankment was the east bank of the Mississippi River, the stream in that year having changed its course southwestward 1½ miles. This embankment is about 40 ft. above zero water and apparently has a sub-drainage during the low stage of the river, causing the bank to slide. A method for stopping the slide, suggested by an engineer of the U. S. Government was to drive piling close together in rows, these rows being at least 50 ft. apart. This method failed.

Later it was decided to drive piling in a manner similar to that of foundation work, spacing the piles from 4 to 6 ft. apart in all directions. This has stopped the slide altogether.

The South Dakota Good Roads Convention.

The first State Good Roads Convention ever held in South Dakota, assembled at the Bijou Theater in Aberdeen on Oct. 26. There was an attendance of 250 delegates from all parts of the state. A considerable proportion of these were county highway commissioners. There was a good sprinkling of farmers in attendance; some of whom were evidently opposed to any change in existing road laws.

Mr. George W. Cooley, State Highway Engineer of Minnesota, addressed the delegates describing highway conditions in Minnesota and the opposition which occurred in that state to the establishment of the present State Highway Commission. Some of the county commissioners seemed to think at first that the movement was for the benefit of owners of automobiles. When the matter became understood, the county commissioners became friendly. The Legislature increased the state highway tax from 1/20 of a mill to ¼ of a mill, and a proposed constitutional amendment is up to increase this tax to one mill.

Mr. Cooley said the system of construction and maintenance of roads by road overseers is extravagant and expensive for the reason that such officers are not appointed because of any particular qualification, and their work is generally ineffective. He said the state labor tax, which authorizes working taxes on the road, yields on an average less than 25% of its full value.

At the evening session Ex-Governor Herried, of South Dakota, spoke on "Needed Legislation." He condemned the statute labor tax as wasteful and recommended that public road construction be put in charge of a state board of highway commissioners. Each county should have an engineer who should report to the highway commissioner.

State Engineer S. H. Lea, of South Dakota spoke on "Better Roads for Farmers," using a number of drawings to illustrate the more technical parts of his address. He said that while the more expensive types of roads are desirable, in South Dakota the best general purpose road is the improved dirt road. He urged proper maintenance and dwelt upon the matter of drainage as necessary for the durability of any road. He exhibited standard plans, prepared in his office, for bridges and culverts, and urged county commissioners to require steel bridges to be constructed of adequate design and under competent supervision.

On the second and final day of the convention, Mr. J. H. Dodge, Office of Public Roads, U. S. Department of Agriculture, discussed the split log drag, stating its merits and limitations. A farmer delegate made a long talk denouncing the good roads movement and as in the interest of the automobile owners. He was followed by two "insurgents" who spoke in much the same strain, but other farmers spoke favoring legislation for better roads.

Mr. Dodge then read a paper on "What the Department of Agriculture is Doing for Improved Roads."

Prof. A. B. McDaniel, of the Engineering Department of the University of South Dakota spoke at the afternoon session. He urged better work in road building and maintenance, and recommended a better class of county bridges.

The convention adopted resolutions recommending a permanent organization to be called "The South Dakota Good Roads League," and recommending the drafting of a good roads law to be submitted to the next Legislature. The convention effected a permanent organization by the election of a president, vice-president and secretary.

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The inevitable timber famine which is rapidly approaching is brought to mind by the statistics of lumber production in the United States during 1909, just made public. These figures show a total production amounting to 44,585 million feet B. M. This is an increase over the production in 1908 of 34.2%, and an increase over the boom year of 1907 amounting to 10.8%. The accuracy of these figures cannot be challenged on the ground that they emanate from some over-enthusiastic advocate of forest preservation. They are issued by the Census Bureau and are in such detail that their reliability will hardly be questioned.

Those who have said there was no need to worry because the forests are rapidly disappearing have comforted themselves with the theory that timber consumption would decrease as substitutes for wood came into general use. A paper read at the St. Paul Conservation Congress by a prominent lumberman expressed this theory as follows:

> Substitutes are coming in to displace the demand for lumber and in the next generation there may be still less call for wood in building. Steel and concrete are making rapid advances.

No doubt, steel and concrete are making rapid advances. Concrete buildings are being erected by hundreds and thousands, and the steel used in building construction now absorbs a very large part of the total production of our steel furnaces. But the use of steel and concrete in buildings does not at all diminish our lumber consumption. This increases at an appalling rate, year by year, as the above figures show. The fact that nearly a third more lumber was cut in the United States in 1909 than in 1907, the year when production in all lines was supposed to have reached a climax, is one of most serious significance.

The census statistics show how rapidly the virgin forests are being swept over. The timber yield of New York and New England has fallen off greatly. The pineries of Minnesota, Michigan and Wisconsin have an insignificant output now compared with their production twenty years ago. Nearly half the lumber used in the United States to-day is furnished by the South. The enormous production is due to the existence of immense mills which sweep the virgin timber from great tracts every year. How long can the South stand this drain?

One Southern State at least has measured its remaining timber resources. Kentucky has found, as a result of detailed surveys, lasting from 1902 to 1909, that at the average rate of output for the last three years, the timber supply of the State will last only 15 years. Similar surveys are to be made in Tennessee; but there is no hope that surveys there or in any other Southern State, will show a more comforting result. The problem how to get along without timber is not one which we can postpone for posterity to consider, in the manner of some who deride the conservation movement. The problem is one which the present generation must meet.

The tariff has been so long an issue in politics that any reference to it in an engineering journal may seem out of place. Yet it is certainly worth while to record here the important movement now under way to take the tariff out of politics.

The following is quoted from a circular letter dated Nov. 2:

> Since the enactment of the Dingley bill, the objection to the old form of tariff-making has so increased in strength, and is so widespread, that even Congress will be compelled to recognize the popular demand for a change in our method of framing the tariff.

This circular is not issued by some political organization engaged in agitating for tariff reform or free trade. It is issued by the National Tariff Commission Association, an organization brought into being by the National Association of Manufacturers, and representing to a great degree the industrial, commercial and manufacturing interests of the country at large, the very interests which have in the past been most influential in maintaining a high protective tariff.

When these interests agree that the time has come to change the time-honored (or dishonored) method of tariff-making, the main support of the high protection system is removed and a change may be confidently prophesied.

What the change will be is indicated by a phrase at the head of the circular before us, which reads:

"To promote the creation of a permanent non-partisan Tariff Commission."

The circular approves the present Tariff Board as a step in the right direction and says concerning it:

> it has also convinced the country that tariff making can be put on a scientific and practical basis by means of thorough, impartial and technical investigations conducted by a competent and permanent Board of Experts, reporting to Congress and the President.
>
> The principal, and by far the most important, lesson it has taught, however, is that a Tariff Board consisting alone of advisors to the President, with a temporary status and no judicial powers, is inadequate and unsatisfactory. This fact is now thoroughly recognized, and is one of the reasons why the National Tariff Commission Association is making every effort to have the present board given additional powers, or, still better, to induce Congress during the session beginning Dec. 8, to transform it into a genuine permanent Tariff Commission with a status equal to that of the Interstate Commerce Commission.

Doubtless there will be opposition in Congress to this move, for the tariff question has been the chief political asset of many congressmen for a generation, and there is a general belief that it has been to many a financial asset as well. The time has come, however, to put an end to this. The public will not stand for it any longer; and the circular before us frankly says:

> A new and important development in the tariff commission problem, one in fact only now becoming appreciated by the country's business interests, is the vital necessity of the commission form of tariff making in order to prevent a radical swing of the pendulum to the other extreme. In other words, a non-partisan, permanent commission of tariff experts is now necessary to protect the industries actually deserving of protection.

We would emphasize the word expert. In all our governmental affairs we can make progress—we can bring about efficiency and honesty only by placing technical matters in the hands of real experts.

A good deal has been said as to the need of engineers taking a larger part in public affairs. It is noteworthy that among the men prominent in this movement to reform our system of tariff making—or rather to bring about system in place of chaos—are a number of well-known engineers. The Treasurer of the Association is Mr. Henry R. Towne, of New York, President of the Yale & Towne Co., who is a Past-President of the American Society of Mechanical Engineers. Mr. Towne is also a member of the Board of Directors of the Association, and another member of the Board is Mr. Charles M. Jarvis, M. Am. Soc. C. E., well known to bridge engineers throughout the country and now Vice-President of the American Hardware Association. Mr. Philetus W. Gates, of Chicago, a former Vice-President of the American Society of Mechanical Engineers is a member of the Tariff Commission Association.

Not for the world would we be so unpatriotic as to make a "Dr. Cook" charge against Messrs. Hawley and Post who, in the balloon "America II.," recently invaded the wilds of Canada on a trip which is claimed to be the longest ever made in an air-borne craft; but, having before us only the somewhat meager data which have been made public, we are curious to know by what mathematical method was computed the 1,353 miles credited to them for the voyage by the Aero Club officials. According to the interviews given out by the aeronauts themselves, they landed some eight miles north of Lake Tshistigama, which lies eastward and to the north of Lake St. John, in the Province of Quebec. This country has never been accurately mapped and the names and locations on the maps available are anything but consistent, nevertheless, it is probable that the place of landing can be located on the best maps with an error of not over 20 to 30 miles.

Taking, then, the latest map issued by the Canadian government we find the landing of the balloon to have been Lat. N. 49°, Long. 71° 30′ west of Greenwich. This is giving the balloonists the greatest leeway possible. Now St. Louis, whence the balloon came, is in Lat. N. 38° 38′, Long. 90° 12′ W. Assuming the equivalent perfect sphere of the U. S. Coast and Geodetic Survey, which allows 1.1516 miles on the earth's surface per minute of great circle arc, the air line distance between the two places is 1,175 miles, in round numbers.

It may be that a balloon record takes into account the lateral and vertical divagations of the inflated bag, in which case we disclaim expert knowledge as to the methods of its computation; but the mathematical shortest distance between St. Louis and the balloon's landing place, as noted above, is so much less than the reported 1,353 miles that an explanation is certainly called for, particularly as the previous long distance record, held by a Frenchman, is 1,193 miles.

Circular letters have been sent out recently by the "Financial Department for the Terry, Tench & Proctor Tunneling Machine Co.," New York City, inviting subscriptions to the company's stock. The letter states that "those able to carry a few thousand dollars' worth of stock will find themselves comfortably fixed for life"; also that "investing in the Terry, Tench & Proctor Tunneling Machine Co. is not only a question of making a safe investment continually paying handsome profits, but one where earnings should make the stockholders rich men and women."

The paragraph of this letter in which we are particularly interested, however, reads as follows:

> We are enclosing an article from "The Engineering News." Their reporter asserts that our present $15,000 model will accomplish the results. It is merely a matter of "any day" now before our machine will be entirely assembled and ready to work; consequently "any day" will see our stock commence to jump until it reaches a point near its actual worth, compared to which, the present price seems insignificant.

The article enclosed, however, is *not* from Engineering News, but from the "Engineering Record." We call especial attention to this matter that none of our readers may be misled by this use of our name.

The Declining Death Rate and the Engineer.

The death rate of the United States for the year 1909 dropped to the remarkably low figure of 15 per thousand population, according to the mortality statistics gathered by the United States Census Bureau under the immediate direction of Dr. Cressy L. Wilbur, Chief Statistician for Vital Statistics, who has recently reported on the subject to Hon. E. Dana Durand, Director of the Census. This is the lowest death rate on record, the corresponding figure for 1908 having been 15.4. It should be understood, however, that this figure applies not to the whole population of the United States, but only to those cities and states which have sufficiently accurate registration of deaths to make it worth while for the Census Bureau to compile and publish their mortality figures. The registration area now covers 18 states, and, in addition, 54 cities in non-registration states. It embraces a population estimated for 1909 as nearly 49,000,000, or approximately 55% of the total estimated population of continental United States. In the registration area are all the New England States, New York, New Jersey, Pennsylvania, Maryland, Ohio, Indiana, Michigan, Wisconsin, South Dakota, Colorado, California and Washington.*

It is interesting to note in passing that the death rate of England and Wales for 1909 was also the lowest on record, having been 14.5 per thousand, as compared with our 15. More remarkable still is the fact that the great metropolis of London had a rate of only 14 per thousand. This, according to the Census Bulletin, "demonstrates the fallacy of the belief that high death rates are necessarily found in large cities." It may be added that still further proof of the fallacy could be found in the death rates of some of our own cities. Thus, of cities of more than a half million population so far announced, the death rates for 1909 were: Cleveland, 12.9; Chicago, 14.6; Pittsburg and St. Louis, each 15.8; New York, 16.0; Philadelphia, 16.4; Boston, 16.8; and Baltimore, 18.7. While not all these cities can claim low rates, as compared with London, yet even the higher ones are creditable, local conditions and the higher earlier rates considered.

It will, of course, be understood that the death rate of any country, state or city is the result of so many and so complex conditions that it is unsafe to attribute its reduction to any one cause or to the members of any one profession. Of the two professions which deal more or less directly with matters closely related to the death rate, the medical profession, of course, comes first, and the engineering profession unquestionably comes second. The primary relations of the doctor to the declining death rate need no discussion. His secondary relations to the death rate are connected with various public-health efforts, official and unofficial.

The engineer, of course, has no direct personal effect upon the death rate, as has the medical practitioner, but through his connection with various sanitary engineering works the engineer does much to improve the public health and prolong life. Some of these relations can best be considered by a brief review of the chief causes of death, as given by the Census Bureau.

In 1909 nearly 200,000 deaths, or about 27% of all deaths in the registration area, were of children under five years of age, and 140,000, or some 10%, were of infants under one year of age. Dr. Arthur Newsholme, Medical Officer of the Local Government Board of England, in a recent valuable study on infant and child mortality, states: "Infant mortality is the most sensitive index we possess of social welfare and of sanitary administration, especially under urban conditions." With the sanitary conditions which most affect infant and child mortality, the engineer has comparatively little to do, for, while proper or improper water-supplies, sewerage systems and other great sanitary engineering works have a marked effect upon infant mortality, yet that effect is small compared with such matters as housing conditions, the general care of the infant and child, and, particularly, the public milk supply. As time and improvements progress, unquestionably the engineer will have more and more to do with improved housing, and also with the public milk supply. His relations to housing will pertain more particularly to heating and ventilating and to a lesser degree to plumbing. His relations to the milk supply will relate chiefly to dairy water-supplies and to various mechanical means for sterilizing milk bottles and other dairy apparatus.

Next to the infant and child mortality in the list of principal causes of death reported by the Census Bureau comes tuberculosis. In all its forms, this disease resulted in about 82,000 deaths in 1909. Although this was an increase of some 3,400 over the tuberculosis deaths of 1908, yet, owing to the increase in population, the actual death rate per 100,000 from tuberculosis fell from 173.9 in 1908 to 167.5 in 1909. The latter was not only the lowest recorded tuberculosis death rate on record for the Census registration area, but for 11 of the 17 registration states (Ohio not being counted here because not admitted to the registration area until 1909) the tuberculosis death rate for 1909 was less than that for 1908. Probably the engineer can lay no very direct claim to having played a part in reducing the death rate from tuberculosis, but undoubtedly he has contributed in greater or less degree through everything which he has done to ensure pure air, and also through those sanitary improvements which tend to diminish the fly nuisance. There is also reason to believe that improvements in public water-supplies have some direct, as they unquestionably have much indirect, effect on the reduction of tuberculosis, but as yet there is not much, if any, definite evidence bearing on this point.

Next to tuberculosis, as a cause of death in 1909, stood pneumonia. Curiously enough, the deaths from pneumonia and from tuberculosis of the lungs were only seven apart in number, pneumonia having caused 70,033 deaths and tuberculosis of the lungs, or "consumption," 70,040. The pneumonia death rate per 100,000 increased from 136 for 1908 to 143.6 for 1909, but even the higher of these two rates was lower than any pneumonia death rate recorded prior to 1908. The causes of pneumonia and of its spread are now sufficiently well understood to lead us to believe that proper housing, including good ventilation, is a very effective means of control; in fact, everything which helps to give a plentiful supply of fresh air and to keep human beings from herding together under insanitary conditions reduces the number of cases and deaths from this serious disease. As we have previously pointed out in our columns, the exposure incident to the work of the engineer and the contractor and the employees under their direction, and the generally unsanitary winter conditions of labor camps, particularly as regards lack of fresh air, are all conducive to pneumonia. While this may have very little bearing upon the total death rate, it is of great significance as regards the health and life of individuals and the healthfulness of camps and therefore should be given careful consideration by the engineer and contractor.

When we come to typhoid fever, there is no question as to the important part which the engineer has played in bringing about the notable reductions of the past few decades, particularly through improved water-supply and sewage disposal systems. For the year 1909 there were only 10,722 deaths from typhoid fever in the registration area, and this was a reduction of 653 as compared with "the somewhat smaller registration area of 1908." The typhoid death rate fell from 25.3 per 100,000 in 1908 to 22 in 1909. The 1908 rate was the lowest in the Census Bureau records, and the rate for 1909 is "nearly one-third less than the rate shown for the five-year period 1901-5" (32.2). Lest those held responsible for this reduction should feel too highly elated over it, and thus cease their efforts, the Census Bulletin from which we are quoting goes on to say that even the low rate of 22 per 100,000 for 1909 in the United States was "more than twice as much as that of England and Wales." To quote further:

> The success already obtained in its reduction should encourage further progress in this direction until residence and travel in this country shall be as safe in respect as in the best regulated countries of Europe where the disease is becoming practically negligible as a menace to public health.

A few detailed figures given by the Census regarding the typhoid decline by states and by cities are of sufficient interest to our readers, we are sure, to warrant their insertion here, as follows:

> Each of the registration states for which data available for the two years, except Washington and Wisconsin, shows a smaller number of deaths from typhoid fever for 1909 than for 1908, and as their population has increased during that time it is evident that the typhoid death rate has likewise decreased for each. Ohio, which was admitted into the group of registration states for the first time for 1909, is, of course, not included in this comparison. If the 1,227 deaths from typhoid fever in Ohio were not included for 1909, the group of registration states as constituted for the years 1908 to 1909 would show a reduction of 1,406 deaths from this cause. The largest numerical reduction is that of Pennsylvania (738), then Massachusetts (132), California (88), Maryland (87), and New York (73). The increased numbers in Washington (23) and Wisconsin (15), were but small and probably less than the relative increase of population.
>
> A considerable part of the reduction in the number of deaths from typhoid fever that occurred in Pennsylvania was due to the decreased number registered in Philadelphia (188) and Pittsburg (125). Of the 50 larger cities, 19 showed fewer deaths from typhoid fever for 1909 than for 1908, and in no city of this group was there any marked increase in mortality from this cause. The largest amounts of numerical decrease occurred in Philadelphia, Pa. (188), Columbus, Ohio (135), Pittsburg, Pa. (125), Boston, Mass. (68), and Chicago, Ill. (61). The greatest relative decrease was that of Columbus, Ohio, from the epidemic prevalence shown for 1908.

All this is very encouraging. The unquestioned relation of engineers to this reduction is shown in part by the fact that the installation of water purification plants at Philadelphia, Columbus and Pittsburg has doubtless contributed very materially to the decline of typhoid fever in those cities. That great engineering work, the Chicago Drainage Canal, and the intercepting sewers and extension of water tunnels farther into the lake, have doubtless all contributed to reduce typhoid fever in that city, although it is not apparent whether the specific reduction in 1909 as compared with 1908 is closely related to those works.

Coming now to accidental deaths, an examination of the figures given below will show that the deaths reported under the various heads were undoubtedly related more or less closely to works with which the engineer has considerable to do, either in their design or their operation. We quote as follows:

> Among the causes of accidental deaths, in the order of numerical importance for the year 1909, were the following: Railroad accidents and injuries, 6,659; drowning, 4,558; burns and scalds, 3,992; injuries at birth, hereafter to be classified under diseases of early infancy, 3,508; injuries by horses and vehicles, 2,152, not including injuries by street cars, 1,723, and automobile accidents and injuries, 632; injuries in mines and quarries, 1,997; inhalation of poisonous gases, including conflagration, 1,837; other accidental poisoning, 1,779; accidental gunshot wounds, 944; heat and sunstroke, 816; cold and freezing, 251; lightning, 150.
>
> There were 1,174 fatal injuries by machinery, chiefly in factories, but the large number, 10,108, of accidental traumatisms of unspecified nature makes it necessary to consider many of the figures given above as only nominal, and it is important that the means of injury be specified in all returns of death from accidental violence.

We leave to our readers a consideration of the possible part which the engineer might take in reducing the number of these various accidental deaths in the future, merely pointing out that he has peculiar opportunity to play a part in reducing deaths from railroad accidents, injuries in mines and quarries, prevention or control of poisonous gases and fatal injuries by machinery.

It will, of course, be understood that we have merely touched upon the relation of the engineer to the death rate as a whole and to the death rate from specific causes. What we have said is designed more to cause engineers to reflect than to point out their duties and opportunities, or to call attention to reasons for congratulation or blame. It also goes without saying, so far as our readers are concerned, that if the engineering knowledge and ability of the country were only utilized to their full extent very heavy reductions in the death rate, both total and from many specific causes, would rapidly follow. It devolves upon the engineer to do what he can to

*All the populations and death rates are subject to corrections based on the results of the Thirteenth Census, but as most of the figures here given are for the whole registration area, the average death rates will be materially changed on final revision for the 1909 Report on Mortality Statistics.

being home these possibilities to the general public. This he can do without any danger of being accused of merely selfish interest. In fact, the task of convincing the public of its duties will be so great that the sacrifices the engineer will have to make to that end will probably exceed any returns in the way of fame or money which will flow from his efforts.

LETTERS TO THE EDITOR.

A Concrete "Pure Arch" Dam.

Sir: The article "Arched Masonry Dam at Las Vegas, N. Mex.," by Mr. C. W. Sherman, in Engineering News, Oct. 27, 1910, p. 446, contains a list of curved masonry dams with principal dimensions. To this list may well be added the Campbell Dam in Cascadilla Creek gorge at Ithaca, N. Y. This dam was built in 1904 and is now in excellent condition. The dimensions were suggested to Campbell Bros., the builders, by Prof. Gardner S. Williams in an offhand conversation. All concerned had forgotten the figures, no regular plans having been drawn, so that in 1907 the writer measured the structure to get the following data:

Maximum height	25 ft.
Thickness base	4 ft.
Thickness top	2.5 ft.
Maximum stress in arch	189 lbs. per sq. in.
Radius, upstream face	70 ft.
Length top	96 ft.
Character of rock	Shale

The 25-ft. height prevails for 35 ft. across midstream. The middle 53 ft. of the top is 3 ft. lower than the end portions and serves as a spillway. The 25-ft. height refers to crest of spillway. For light reinforcing, ½-in. round wrought iron rods were placed horizontally near each face and spaced 12 ins. apart.

So intense was the discussion concerning the then proposed 90-ft. dam in Six Mile Creek gorge that few of Ithaca's citizens were aware of the building of the Campbell Dam, nearly as daring (as they say) in proportions as the former. Even to-day very few know the nature of this dam in the heart of the town, for it looks so strong and does not frighten the timid as perhaps would a view of its cross-section on a blue print.

Very truly yours,

Ithaca, N. Y., Oct. 28, 1910. Ernest W. Schoder.

The Study Hours of Engineering Students.

Sir: An editorial in Engineering News, Oct. 20, 1910, p. 419, criticizes the college professor who requires his students to give two hours of time in preparation for each recitation. The editorial endeavors to show that two hours of preparation are not commonly required, that if it were the student would have little time for eating, sleeping and recreation—so much study would make Jack a dull boy.

Although it may be acknowledged that professors are sometimes overzealous and ask that an unreasonable amount of time be given by students in preparation for their respective courses, still in the example criticised by you it would appear that the time presupposed by the professor is in accord with common practice and is perfectly reasonable.

You state that "For the man whose class-room work runs to the normal of 18 or 20 hours a week, we can hardly see where proper allowances for eating, sleeping and modicum of exercise can be made, when the added 15 to 20 hours of drafting-room and laboratory work are also accounted for." You would doubtless be justified in regarding 18 to 20 term-hours as a normal requirement in our American colleges, but it would be unreasonable to add to that 15 to 20 hours more of drafting or laboratory work. In any college where 25 term-hours should be required, it would simply mean that less than the usual two hours is given in preparation for each recitation, since the sum total of study and recitation hours per week does not vary widely in different colleges.

The total hours required of students in the Engineering School of Tufts College and the division of their time among the requirements of laboratory or field, recitation and preparation, is shown in the following tabulation. (A laboratory or field exercise requires no preparation, but each recitation calls for two hours of preparation).

	Required term-hours per week.	In laboratory drafting or field.	Recitations.	Preparation outside.	Total hours, class and preparation.
		Hrs.	Hrs.	Hrs.	
Freshman 1st half year	17½	20	8	23	51
2d half year	18½	15	12	27	53
Sophomore 1st half year	18½	25	10	20	55
2d half year	18½	22	10	23	55
Juniors 1st half year	18	27	9	18	54
(Civil Engineers) 2d half year	19	18	13	26	57
Seniors 1st half year	15	9	12	24	45
(Civil Engineers) 2d half year	15	13	10	22	45

Also one or more optional courses are usually taken in Senior year.

The foregoing table shows that the total hours for class and preparation range from about 50 to a maximum of 57, and the term hours average about 18. This would show that the ratio of total time to term hours is about three to one, or that for each recitation two hours of preparation would be counted. It should be explained, however, that the college hour is usually understood to comprise a recitation hour of about fifty minutes, and when a professor calls for two hours of preparation, it would frequently be construed as two college hours, so that a total of 54 hours would mean 9 college hours per day for a week of 6 days. This, however, when reduced to its lowest terms, means that a student is expected to give to his college courses 8 to 9 hours, or actual time for 5½ days per week. His time is ordinarily divided into 6 or 7 hours of work in the daytime and 2 hours in the evening. It is possible, however, to cite many instances that show wide variations from these normal requirements.

Thus, we find at Tufts College that many of the students entering college after a few years of practical experience come with the determination to improve all of their time. They not only endeavor to take programs that exceed the required amounts, but they frequently use in preparation much more time than has been allowed in the above table, and will work even 10 or 12 hours per day. On the other hand, a student who shirks, or one with a variety of college interests, or who is compelled to earn money to pay his way, will get along with less time, and instead of 9 hours will reduce the amount to, say, 6 hours per day for the 5½ days a week.

But my experience, which has included teaching in three of our New England colleges and one of the large State universities, indicates that it is common practice to require two hours of preparation for each recitation, and I believe you would find, upon investigation, that the professor who presupposed the above amount of time in preparation for his course was strictly in accord with custom and was not making an unreasonable requirement.

Yours very truly,

Frank B. Sanborn,
Professor of Civil Engineering.

Tufts College, Massachusetts, Oct. 31, 1910.

[From the above letter and from other similar communications that we have received, we would judge that this two for one ratio is a cardinal principle of technical education. We wonder if these professors who *require* their students to study two hours for every one in which they are at recitation, recall Glendower's boast "I can call spirits from the vasty deep" and Hotspur's tart reply "Why, so can I or so can any man; but will they come when you do call them?"—Ed.]

A Civil Service Examination for Testing Engineer in the Bureau of Forestry.

Sir: The following list of 19 questions is given from an examination of applicants who aspired to become Testing Engineers in the U. S. Bureau of Forestry. The questions are quoted, of course, from memory, as the rules forbade the applicants taking any notes from the room in which the examination was held. Of the 19 questions, 14 were to be answered within seven hours of continuous work. Hence, the applicant who took a lunch in his pocket was wise. The other five questions were to be answered afterwards at the home of the applicant, and forwarded within five days to the Commissioner.

A study of the questions will show that they require a knowledge equivalent to that acquired from a college course in applied mechanics, together with practice in the laboratory of experimental engineering. They also require a technical knowledge that would be gained by the applicant if he had been engaged directly in lumbering, or if he had made a study of literature on forestry in connection with milling and woodworking.

The papers were in five parts: (1) for information about address, age, citizenship, health, etc.; (2) about height, weight, color of eyes and hair, salary expected, salary now received, location desired, by whom employed, where educated, etc.; (3) records of professional experience; (4) seven questions on technique of testing; (5) seven questions on mechanics of materials. The substance of sections 3, 4 and 5 are given below.

Very truly yours,

"Candidate."

TRAINING AND EXPERIENCE.—The answers to these questions are to be mailed to the Commission at Washington within five days from the date of examination:

(1) What training and experience have you had in mechanical engineering? What courses were taken? Where and under whom you have worked?

(2) What training have you had in mathematics, chemistry, botany and forestry? What courses were taken? Where and the men under whom you have worked in these lines?

(3) What experience have you had in actual work of testing materials of construction or in preserving woods? What was the character of the work, for whom, and for what purpose was it done?

(4) What experience of any kind have you had in the manufacture of lumber or in wood construction? Describe in detail the work done.

(5) What experience have you had that would give a good knowledge of the physical properties of American woods? Describe the length and character of such experience and mention the woods with which you have become the most intimately acquainted.

TECHNIQUE OF TESTING:

(1) (a) Sketch an instrument for measuring the extension of steel to determine its coefficient of elasticity, (b) cement in compression, (c) steel in torsion.

(2) What are the most important requirements of a testing machine to assure delicacy and accuracy? How would you inspect the machine to determine these points? Sketch the principal mechanical features of an Olsen or a Reihle testing machine.

(3) Explain the following terms: cup-shake, heart-shake, dote, wane, sap stain, heart, sap-wood.

(4) (a) Classify the different kinds of knots. Tell how the kind, size, and location of knots affect the strength of timber in flexure, shear and compression; (b) What determines the formation of the different kinds of knots in growing trees?

(5) Under what conditions of exposure will wood decay? Name three ways to prevent decay of wood. Describe a process for treating green sap fir trees on a large scale.

(6) What effect has kiln-drying on wood? What is the largest sized piece of wood which can be kiln-dried? What effect has moisture on the strength of wood? State reasons. Describe one process of kiln-drying. How is the strength of timber affected by its location in the tree?

(7) Write specifications for the following: Warehouse joists, long-leaf pine piles, bridge stringers.

MECHANICS OF MATERIALS:

(1) Define modulus of elasticity, elastic limit, yield point, modulus of resilience, proportional limit, ultimate strength. How do these values compare for a high steel?

(2) Develop a formula for determining the modulus of elasticity and ultimate strength, in flexure, of a beam supported at the ends and loaded at the third points. The given deflections are the vertical displacements of the middle of the beam measured from the level of the corresponding points above the surface.

(3) (a) Determine the size of the stringers on a trestle which sustains a load of 10,000 lbs. per lineal ft. and is 14 ft. between supports, and with three stringers under each rail; (b) Determine the dimensions of a loblolly-pine derrick pole, 40 ft. long, to sustain 8,000 lbs., axially.

(4) An 8 × 8-in. beam is supported at the ends 8 ft. apart. From what height over the center of the beam should an 800-lb. weight be dropped to produce a maximum fiber stress of 5,000 lbs. per sq. in.? Show the development of the formulas.

(5) State the ultimate strength in compression and flexure, and the specific gravities, green and dry, of the following woods: long-leaf pine, loblolly pine, white pine, shell-bark hickory, western hemlock, red fir, oak, ash, cottonwood, spruce, beech.

(6) What kinds of wood are used for the following, and why? Ax handles, shovel handles, derrick poles, ship masts, furniture, castors, harvester poles, durable fence posts, packing boxes, wagon tongues, wood pulp, patterns, steps, bent ware, spokes, furniture requiring beautiful finish, furniture requiring permanency of form, car sills.

(7) A stick of wood, 10 × 10 ins. and 40 ins. long, is supported at the ends. Its modulus of rupture, in flexure, is 5,000 lbs. per sq. in., and its shearing strength is 600 lbs. per sq. in. Will the stick fail by pulling apart, by bending, or will it split horizontally at the ends? Give the calculations.

Forest Fires and Pine Beetles in the Black Hills.

Sir: I have followed, with considerable interest, the discussions pro and con as to the proper way to fight and to prevent forest fires. As my experience has been limited almost entirely to one locality, I do not wish to wade beyond my depth in this controversy. However, I would like to make a few comments on a letter published in your issue of Oct. 27, 1910, which you published by permission of Mr. Abbott and which was credited to an Eastern engineer.

It is stated in that letter that "six years ago there was scarcely a dead tree in the Black Hills." This statement, together with what follows, seems to place the blame on the Forest Service for the presence, or, at least, the continued presence of the pine beetle or boring grub. It is the truth of this statement that I wish to challenge.

In the summer and fall of 1896, the writer was engaged with Mr. Frank S. Peck, of Deadwood, South Dakota, in making surveys of the township boundaries, in what is now the Black Hills Forest Reserve. At that time we noticed that small patches of the very best timber were dying, and, upon investigation, we found that the trees were being killed by a little brown bug.

That was fourteen years ago, and the brown patches in the green pines of the Black Hills kept growing larger from that time until four or five years ago, when the little bug seemed to lose some of its activity, and now its ravages have almost ceased.

As it was several years later than 1896 when the officers of the Forest Reserve took active charge of forest fire-fighting in the Hills, it seems like rubbing it in a little too hard to lay the loss of timber in the Black Hills at the door of the Forest Service.

Much of the timber killed by the bugs had decayed and fallen down at the time the writer of the above-quoted letter says there was scarcely a dead tree there. At that very time lumber camps were established in many parts of the Hills, and were busily engaged in cutting the dying trees before they became entirely unfit for use.

During the ten or twelve years when the pine beetle was most active, the fires were burning with their accustomed regularity, but the boring grub kept on boring.

"The old settler" spoken of in the letter would have a hard time proving to the average inhabitant of the Black Hills that the boring grub has killed more timber than have the forest fires. There are large areas around Lead and Deadwood, and, in fact, all over the Hills where old burned snags and small jack pines tell the tale of the ravages of the forest fires. Not only was the timber on the burned areas entirely destroyed, but the new growth, and, in some places, even the cones, were burned, so that after ten or fifteen years the ground is still naked.

If one could find an ideal forest where all the trees were large, and no undergrowth or young trees grew, and the ground under the trees was covered with only a thin covering of pine needles, I will grant that a fire running through this ground covering would do no harm, provided the wind did not carry the fire into the treetops.

I agree most heartily with Mr. Coert Du Bois that strict patrol during the dry season and proper supervision of cutting is the only way to reduce the loss from fire in our forests. Private owners of timber lands in the Black Hills are beginning to work along these lines. Instead of trusting their trees to the mercy of a fire running quietly along the ground, they try to prevent the fires and burn their tree tops in small piles.

From what I know of the pine beetle, the hot flames are more injurious to the young pine tree than to the beetle.

Yours very truly,

Bruce C. Yates,

Asst. Chief Engineer, Homestake Mining Co.

Lead, S. Dak., Nov. 1, 1910.

[We may add to the above letter, that if forest fires had been necessary to hold in check insect or other parasitic enemies of trees, the original forest which once covered much of the continent could never have grown and matured.—Ed.]

Notes and Queries.

Mr. David H. Ray, who was mentioned in our personal columns of last week as a Junior Member of the American Society of Civil Engineers, had been made an Associate Member since the last published list of members of that society. Mr. Ray is Chief Engineer of the Bureau of Buildings, New York City.

Laying and Repairing Cast-Iron Pipe Culverts in Railway Embankments.*

The subject assigned to this committee is "How to prevent iron-pipe culverts from pulling apart in soft ground, and how to repair them when pulled apart." A number of members state that they would take great care in putting a substantial foundation for the pipe, using old bridge timber for grillage and a cradle; or a concrete foundation the whole length of the pipe, or concrete piers under the joints, thus avoiding the danger of pulling apart. Various methods were suggested for repairing broken pipe or joints that were pulled apart. Some use rods with turnbuckles or having threaded portions to draw the pipe together. Many, however, advocated digging up the pipe and relaying, or digging down to the joint and repairing with concrete.

W. C. Cushing (Chief Engr. M. of W., Pennsylvania Lines).—In placing cast-iron pipe 24 ins. or more in diameter, build under each joint a block of concrete, 12 in. thick, 24 in. wide, and 48 in. long, parallel with the track. The pipe should be laid before the concrete is placed, so that it will get a good bond on the hub of the pipe. The ground around the pipe, for its full length, should be carefully tamped. Where pipes are put under tracks in service the stringers supporting the track should be left in place for several months, until the ground has become well settled around the pipe, before the full weight is thrown on it.

In slips, the best method of holding the pipe in place is to carry the small concrete piers to the bottom of the slip, if this is not too deep. In cases where the slips have been deep, we have driven pile foundations, three piles in a row, spaced 2 ft. on centers, parallel with the track, and spaced 4 ft. c. to c. parallel with the pipe. The tops of the piles were concreted and the pipe laid on concrete. Where a culvert in a slip was treated as above, in 1907, no movement has since occurred, either in the pipe or in the slip.

M. M. Barton (Pennsylvania R. R.).—I have laid one 4-ft. and one 6-ft. cast-iron pipe in 12-ft. sections in the bed of a drainage canal, where there was a soft mud bottom. We constructed a raft of old trestle timber the entire length of the culvert, with a bolster or cradle spiked on the raft for the pipe to rest in. We floated the raft in place under the roadway, anchoring it to the pile trestle bents which supported the track. After it was secured in position we laid the pipe at low tide and followed with the fill.

R. G. Develin (Asst. Engr. M. of W., Pennsylvania R. R.).—Our tracks along the Monongahela River seemed to move toward the river and separated a 24-in. pipe culvert. It was put back and clamped as shown in Fig. 1. Another culvert pulled apart owing to the settlement of the fill and the pipe not being properly supported. We dug down around the joints of the pipe and concreted around them; we also built parapet walls at the ends. All pipe in a fill should be laid on a bed of old ties, to insure a good bearing.

We have never had any experience with iron pipe culverts pulling apart in soft ground, but the trouble could be corrected by putting an iron tie clamp on top of the pipe; drill holes through the bell and spigot ends, and then fasten this tie clamp with bolts. If the pipe pulled apart enough to allow the spigot end to be out of the bell, I do not think good repairs could be made without taking the ground off the pipe and putting it back in place. If the pipe had not been pulled apart far enough to allow the spigot to be out of the bell, my method of repairing would be to bolt some tie pieces across the joints to keep it from going any further and then fill the open spaces with concrete.

On the mountains, or where our pipe culverts have much of a fall, we clamp them together with three clamps 3x¾x16 ins., as shown in Fig. 1. We do not put any clamps on the bottom of the pipe, as we want

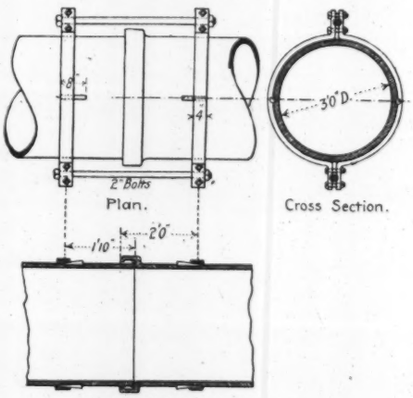


Fig. 1. Repairing Joints in Iron Pipe Culverts; Pennsylvania Ry.

to leave the bottom surface as smooth as possible. We have been doing this for some years and have had no trouble with our pipes pulling apart.

D. C. Zook (Pennsylvania Lines).—Where the ground is moderately soft we lay a floor of track ties, the ties being at right angles to the pipe and as close together as possible. A saddle is formed by a timber on each side of the pipe, having its inner face chamfered to fit the curve of the pipe as nearly as possible. When the pipe is 3 ft. or more in diameter we use timbers about 12 in. square. When the ground is too soft to allow this mode of construction, we drive two-pile bents at about 6 ft. centers, the pipes being 12 ft. long. We cap those piles and on this foundation lay our pipe, supporting it between bents with the saddle already mentioned made of 12x12-in. longitudinal timbers fitted up to each side of the pipe and securely fastened to the cap. The object of the timber is to afford additional bearing to the pipe and prevent it from crushing.

We have obtained good results from these methods and have never had any trouble where they were used. When we first began using cast-iron pipe for this purpose we had trouble with our pipes sinking, as they were not supported other than by earth. We then had to dig them out and support them.

S. C. Bowers (P., C. C. & St. L. Ry.).—We had a case of pipe pulling apart in a slip where solid ground was about 6 ft. below the bottom of the pipe. We excavated to the rock and into it about 6 ins., and built up small concrete piers under the joints. The pipe pulled apart about 2 ft. before this was done. The work was done early in 1908 and there has been no trouble since.

W. Benton (B. & O. Ry.).—We had a 36-in. pipe culvert with pile foundation settle to one side on account of soft ground on that side and solid ground on the other. We had to uncover it and couple up the pipe. After we got it in place we used a 2¼-in. rod 60 ft. long, running it through the pipe and anchoring it at each end. Another culvert settled and the [illegible] pulled apart. We put it back on a concrete four[illegible]n and then buried it in concrete. Have had no [illegible] with it since that was done. We have laid cas[illegible] pipe culverts in soft ground on timber foundation[illegible] or 12 ft. wide and the full length of the pipe. W[illegible]erally use for this purpose second-hand bridge tim[illegible] Water covering the timber prevents decay.

D. B. Taylor (B. & O. Ry).—I have clamp[illegible]e pipe together by using a hoop made either of ro[illegible]r flat iron (size 1¼ ins. for 24 to 36-in. pipe), wi[illegible]ree or four eyes at equal distances apart, placed [illegible]e extreme upper end of the culvert. This hoo[illegible]pe is made the exact size of the large part of t[illegible]l end of the pipe, and similar hoops are made to [illegible]placed below each of the bell ends of all the lowe[illegible]rts, to fit the outside of the pipe neatly, with six to [illegible]t eyes in them for rod connections. The rods have [illegible]readed ends with nuts, to be tightened with a w[illegible]h and equally adjusted.

To repair a culvert which has been pull[illegible] apart: Make a flat iron band similar to the round [illegible] with a suitable number of eyes. Place this on the [illegible]e that is permanently located under the fill and drill [illegible]hree or four holes through it. Put in a short button [illegible]d bolt with nuts on the outside. Use the rods from [illegible]he eyes to below first bell in similar bands with eyes [illegible]and so on until the last end. Then use a hook or [illegible]he bent lower ends of the rods to catch on to the spigot end of the pipe. Adjust all of the rods in this way to get equal weight on the same. This will prevent the pipe from parting.

R. H. Reid (L. S. & M. S. Ry.).—For iron pipe culverts in extremely soft ground we have sometimes driven piles on both sides, capping these piles just back of the bell, so as to form a two-pile bent under each 12-ft. section of pipes. Or if the conditions warrant, we put two bents of two piles each under each section of pipe and place the pipe on saddles, the saddles being cut out to fit the curve of the pipe. We then fill in carefully over the pipe. In addition to this, where necessary, we have placed iron rods entirely through the pipe on the inside, with hooks over each end of the pipe and with one or two turnbuckles in the rod for drawing them up tight.

In other cases of soft ground where the conditions have not been bad enough to require pile bents, we have placed old ties or old bridge stringers for saddles and have laid the pipe directly on them, clamping the pipe together with rods, as above mentioned. In one or two cases we have drilled holes in the pipe near the end and fastened the sections together with iron straps bolted through these holes. Where pipe culverts have pulled apart in soft ground, it is generally necessary to dig out one or two sections at each end, depending upon conditions, and close up the joints by resetting the pipe; and, if conditions seem to require it, place the iron rod clamp through the pipe culvert.

J. H. Roach (Division Engineer, L. S. & M. S. Ry.).—I have in mind a waterway constructed of 24-in. cast-iron pipe in soft ground under a 100-ft. embankment. Fig. 2 shows the culvert as actually built.

The character of the natural ground and its action when under heavy loads was well known before the work was started, and on account of the high fill to be placed over the pipe it was deemed necessary to take every precaution possible to prevent the pipe from settling and pulling apart after the fill was completed. Accordingly, 50-ft. white-oak piles were driven for a foundation and the pipe was encased in concrete reinforced with bars placed longitudinally, to take care of the tension likely to result when the fill was made. After the structure was completed, the fill for a height of about 23 ft. above the pipe was placed in position in layers about 4 ft. thick with teams and scrapers, which compacted it well. Later the fill was carried up to grade in the usual way, and, although stakes placed in the natural ground north of the north end of pipe showed a movement of about 12 ins. to the north and a rise of 12 to 24 ins., there was no appreciable change in the grade or alinement of the pipe.

J. P. Snow (Chief Engr., B. & M. R. R.).—I have never experienced difficulty with pipe culverts pulling apart. For small pipe I would recommend the lock-joint pipe, which comes in 4-ft. lengths and is cheaper than bell-and-spigot pipe. For large pipes, if the foundations is such that future movement is feared, I would recommend a timber cradle for the pipe to rest on. Where pulling has occurred in an existing culvert, if the pipe was large enough for the workman to enter, I would work rich mortar into a ring to fill the space. If the pipe was too small for this I would try grouting the fill with a grouting pump, either from the top of bank or by a pipe with an elbow, worked from the end of the culvert.

J. P. Canty (B. & M. R. R.).—It has been our practice to drive two rows of plank sheeting parallel to line of culvert and about 12 ins. farther apart than the outside diameter of the bell end of the pipe. Between these, after excavation has been made to proper depth, a 6-in. floor of concrete is laid. Upon the latter the cast-iron pipe is placed, and the space between the pipe and sheet-

*From a committee report presented at the annual meeting of the American Railway Bridge and Building Association, at Denver, Colo., Oct. 18, 20. We give extracts from a few only of the individual statements accompanying the report. In the discussion it was mentioned that both the Chicago & Northwestern Ry. and the Intercolonial Ry. (Canada) are using concrete pipe as well as cast-iron pipe for culverts.—Ed.

is filled with concrete. We also cover the pipe on to depth of 6 ins. with concrete. The culvert pipe hereby enclosed in a concrete casing that is square the outside, the dimensions being about 12 ins. ter than outside diameter of the pipe. As an adonal precaution the plank sheeting is sometimes left place.

ith concrete heads on these culverts, the foundations which are carried about 3½ ft. below the bottom of culvert opening, we have had no trouble. The length, ght, and thickness of head walls will of course, de-

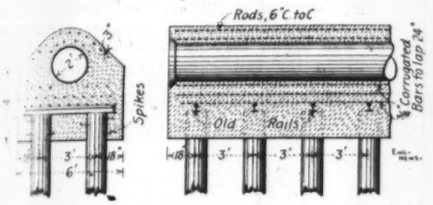


Fig. 2. Iron Pipe Culvert Encased in Reinforced Concrete on Piling: Lake Shore & Michigan Southern Ry. (Cleveland Short Line).

pend upon the height of the fill behind the same. Cases where pipes were broken under the track or pulled apart have not bothered us, as I now can recollect, except in places where there have been comparatively low fills. In these situations we simply put temporary stringers under rails, resting on the earth at the ends, of sufficient size to carry the load for the opening desired, and after excavating down to the pipe relaid it as outlined above. In deep fills, where extremely long piles would be necessary to make an opening down from the track for such cases, I would advise tunneling from the end of culvert, if it was not possible to remedy the trouble from the inside of culvert pipe.

It may be pertinent to state that, with concrete casings, as described, I have found that tile pipe apparently answers the purpose as well as cast iron, even when the top of the culvert is comparatively close to the ties.

F. L. Stuart (Chief Engr., Erie R. R.).—While it is true that no pipe should be put in where the foundations are so soft that it is liable to pull apart, in unimportant work the risk is sometimes taken on the score of economy. In such cases the plan which offers the most hope of holding the pipe together is to lead the joints, put in a gravel foundation, build walls and tie them together independently of the pipe. The tying of the head walls would give some play to the pipe, whereas if clamps were put on at each joint they virtually make a girder of the entire pipe, and a settlement of the embankment will break this girder much sooner than it will open up the pipe with the head walls tied together. We have had very little trouble with iron pipe culverts pulling apart, but have had several failures which were of such a character that I do not think clamps would have done any good. Water companies use clamps and turnbuckle-rods occasionally, at bends in high-pressure lines or at dead ends.

R. C. Young (Chief Engineer, L. S. & I. Ry.).—I have seen instances where it was necessary to put iron pipe culvert on soft ground, and before laying the pipe a foundation was prepared on piling, with concrete coming half way up the side of the pipe. In such cases I think it is better to build a concrete arch. I have had two

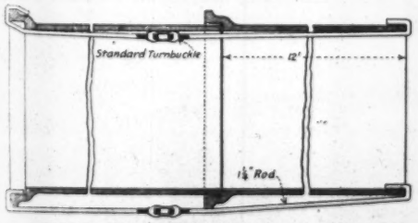


FIG. 3. CLAMPING IRON PIPE CULVERTS LONGITUDINALLY.
(This method is used by several railways.)

instances where iron pipe failed, one under a 65-ft. bank and one under a 95-ft. bank. This pipe failed by splitting due to pressure, and we were unable to repair it in any way. We found it necessary to drive tunnels through the dumps and put in concrete culverts to replace the pipe.

G. A. Wright (Illinois Traction System).—I have pulled culvert pipes back with a heavy chain and steamboat ratchet. In some cases I have found it necessary to excavate down to the top of the pipe and alongside to about the center of diameter, before being able to move them. The rods used were made up in 12-ft. lengths, and these sections were coupled together with welded ends. Old bridge rods were utilized for the material.

A. S. Markley (C. & E. I. R. R.).—After laying pipe in place fill the bell around the spigot end of the pipe full of 1:3 grout, well mixed and stirred up while pouring, so that the sand and the cement will not separate. Care should also be taken that a clay roll or pipe jointer is held firmly against the bell of the pipe, to prevent the grout from escaping through an open seam. This has been our practice for the past ten years, and has proved very successful. Previous to using this method, in a good many cases, joints of pipe would partly separate, more particularly those on the outer ends of high banks, until the bead on the spigot end of the pipe would pull apart sufficiently to engage in the groove in bell end. In some cases, very rarely, the ends of the pipe will pull out of the bell, disconnecting the joint.

Where the ground was soft and the pipe likely to settle irregularly and out of line, and cement calking is not likely to hold, I have put three 1-in. rods hooked over ends of pipe, with turnbuckles in the center of each rod, on the inside of pipe, to pull the sections firmly together before filling (Fig. 3). The rods are at equal distances apart. If advisable the joints can be grouted, as above explained. After the pipe has thoroughly settled to a firm foundation the rods can be removed.

The only successful way of repairing pipe that is pulled apart under heavy banks is to dig them out and reset them. Under light banks with open joints near the ends, I have jacked the ends up in line and pulled them together with crab and block-and-fall, either by anchoring the same at opposite ends of the pipe or by using jacks instead. Where the pipe has crushed under heavy banks I have lined them with one row of brick, laid rollerways, in cement mortar. Such was done where the pipe was sufficiently large to take care of the water after lining. In one case this was done under a 60-ft. bank and a 36-in. pipe flattened 3 ins. out of true shape. This happened ten years ago and the pipe is still in good condition. In this case the pipe was broken under the center of the bank. At the ends of the pipe, where it was undisturbed, no brick was placed. Where the brick terminated a sloping offset of cement mortar was put in to prevent drift, etc., from lodging against it. No trouble has been experienced in consequence of this lining.

In unloading and rolling iron pipe from cars where the ground is soft, the spigot end should be laid on the

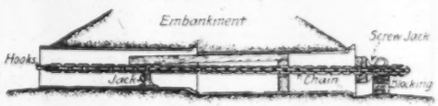
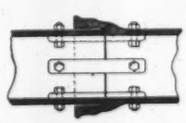


Fig. 4. Adjusting Displaced Pipes of Iron Pipe Culvert by Jacking; Chicago & Northwestern Ry.

ground first, to prevent breaking. If the bell end strikes the ground first, almost invariably the spigot end will either crack or break. On hard ground, pipe should be snubbed off cars with a rope and skids, to prevent damage and breaking.

Lee Jutton (Inspector, C. & N. W. Ry.).—In repairing an open joint in a cast-iron pipe culvert when the distance from base of rail to the bottom of the culvert is 5 ft. or less, the pipe should be dug out and relaid, at the same time providing a good foundation. When it is not advisable to do this, the joint can be repaired with concrete and cement. To do this the dirt should be taken out as much as possible under and around the pipe at the open joint, and the space thus formed filled with concrete, finishing on the inside with cement mortar. If the waterway can be reduced, a 6-ft. length of pipe having no bell may be put inside to cover the open joint. The difference in diameter between the two pipes should be enough to allow 2 or 3 ins. of concrete to be placed between them. At the upstream end of the short length, the concrete should be tapered off, so that there will be no abrupt obstruction to the water.



W. F. Meyers (C. & N. W. Ry.).—Fig. 4 shows my plan for pulling pipes together without excavating, where the embankment is not too high and all that is required is to pull them back to place. They can be held in place by drilling a few holes in the bell and inserting bolts through both pipes from inside. Of course this can be done only where the pipe is large enough for a man to get inside to work.

J. D. Moen (C. & N. W. Ry.).—If the pipe be large enough for a man to work inside (say 36 ins.), and the aperture is not too great, it might be cleaned out properly and filled with cement concrete. Where the pipe is pulled part and either end has not settled below the line of the other section, a steel jacket might be fitted tightly on the inside to prevent any leaking or wash. If repairs are made with concrete, as mentioned above, it would be difficult to fill the upper part of the aperture.

E. J. Auge (C., M. & St. P. Ry.).—We have, in very soft ground, put timber lengthwise with the pipe. This, to some extent, has helped to keep the pipe together at the joints. The pulling apart of pipe is due more to the action of the trains than to the settling of the grade. In a large majority of cases where pipe was pulled apart I found that the pipe had not sagged or settled out of surface, but the joints were pulled apart from 1 to 4 ins. I think the lock-joint culvert pipe would prevent the joints from pulling apart in all cases except in a newly made fill that has not thoroughly settled. I have not been able to find anything that would stop culvert pipe from pulling apart in soft ground in a newly made embankment.

To replace pipe that has pulled apart, we sometimes are able to jack it back, but in the majority of cases we have to dig around the sections to get them back to place.

Efflorescence on Brick Work.*

By A. F. GREAVES-WALKER.†

COMPOSITION OF EFFLORESCENCE.—Wherever brick are used for building purposes, brick walls will be noted which are covered or partially covered with a film of scum. This scum is generally white but may be yellow or green. It appears at its worst on red brick walls, but may be seen more or less plainly on brick of any color. When the walls are new it appears as white blotches at various places. Later it may come out all over the building, giving the brick work a faded or dirty appearance. In a few years a red brick building so affected will take on a faded pink appearance which will stay with it forever.

The scum is simply a film of soluble salts carried from the interior of the brick to the surface by the water which they absorb, and left there after it evaporates. The scumming is always worst near the eaves and downspouts, and under the window-sills and water table. This is caused by leakage of rainwater between the roof and trough and from the downspouts, and through the catching of the water by the sills and water table which consequently soaks into the brick beneath.

The scum is generally composed of sulphates, although it may be composed of any other soluble salt. Chlorides are found in seacoast clays and alkalies in clays of the Western arid region. In the clays of this country, the scum causing salts, in order of their abundance are:

(1) $CaSO_4$, calcium sulphate; (2) $MgSO_4$, magnesium sulphate; (3) K_2SO_4, potassium sulphate; (4) Na_2SO_4, sodium sulphate; (5) $FeSO_4$, ferrous sulphate; (6) $Al_2(SO_4)_3$, aluminum sulphate.

Often all of these occur in a single clay, especially if it has been weathered and subjected to the attack of decomposing pyritiferous minerals.

CAUSES.—All of the above salts are very soluble except calcium sulphate, which is soluble 1 : 400. But this is great enough to completely ruin face brick in which it occurs, as the surface is small in comparison with the weight. This particular salt, in fact, is probably responsible for half the ruined walls in this country. The sulphates of soda, potash, and magnesia will often cause scum when present in the most minute quantities. As little as 0.01% of any one of these salts has been known to ruin face brick.

There are four ways in which salts are incorporated into the brick: (1) soluble salts in the clays or other materials used; (2) soluble salts in the water used for tempering the clay; (3) soluble salts formed in kilns by oxidation of minerals in clay, or by reaction of sulphurous kiln gases on clay; (4) soluble salts introduced into brick after burning, principally from mortar.

A great majority of clays contain soluble salts, some large quantities, others but a trace. Surface clays are more likely to have a high content than the older deposits. Trouble is encountered in all parts of the world from this source, and probably 75% of the scumming comes from this cause.

Often materials are mixed with clays that carry soluble salts into them. Examples of this are the brick made around London, England, in which ashes are used to reduce shrinkage, and brick made along the Hudson in which coal slack is used to aid in burning. In both of these cases the soluble salts in coal add to, if they do not entirely produce, the scum.

In the clays that vitrify, scumming can be overcome by burning them to a vitrified body, in which case the salts form silicates and become harmless.

The water used for mixing and tempering mud brick often contains soluble salts. This, of course, produces the same effect as if the clays contained them. Many good clays are injured in this way.

The formation of soluble sulphates in the kiln is a very common trouble. It is often encountered with clays that contain practically no troublesome ingredients before being fired. In many cases there is really no excuse for trouble at this stage. It is simply a case of ignorance on the part of the brickmaker or poorly

*From a paper in the "Journal of Industrial and Engineering Chemistry" of the American Chemical Society, Sept., 1910.

†Salt Lake City.

designed kilns and stacks. When a kiln is set and the heating-up process is started, the ware contains considerable moisture. If good judgment is used and the fires are kept at such a stage that only so much of the moisture is being driven off as the sluggish draft of a cool stack will carry off, trouble is not likely to occur; but if the moisture is driven off more rapidly than the stack can handle it, it is precipitated on the ware again, when it absorbs sulphur from the gases and forms sulphuric acid. This acid attacks the carbonates and other less soluble salts and forms soluble sulphates.

There is no doubt that considerable trouble is caused by the mortar in which the brick are laid. Poorly mixed mortar is dissolved by the rain water and the salts carried into the brick, only to be brought to the surface later. It is therefore always important to take great care with the mortar.

METHODS OF OVERCOMING SCUM.—Many methods are employed to overcome or prevent scum. It is possible to do this in nearly every case, but is often impracticable on account of the low selling price of the ware. Where facing brick or other wares are made by the wet process or where the ware is vitrified there is practically no excuse for trouble.

The preliminary treatment is the principal method of overcoming or preventing scum. This is done by treating the clay or treating the water used.

TREATING THE CLAY.—Clays that contain soluble salts can be washed before using and the salts leached out. This may be done by treating piles of clay, after mining, with water and then allowing them to dry. This method is only possible where high-priced ware is made. Clays are often allowed to stand in piles for from six months to a year, in which case the rain and snow do the same thing.

In many clays the above methods will only cause the trouble. This would be the case where a clay did not contain soluble salts originally, but upon exposure to the weather insoluble salts were converted into soluble salts. This would be the case with pyritiferous clays.

Chemical treatment is very often resorted to. This is accomplished in clays made up by the wet process, by adding, to the water used, such chemicals as will precipitate the soluble salts and form harmless by-products, such as barium sulphate. Barium salts are the favorites with which to accomplish this reaction, but others can be used; barium chloride and carbonate are most commonly used.

In case soluble sodium compounds are present, the addition of the above-mentioned barium salts would form either sodium carbonate or chloride, both of which are soluble. However, they are so soluble that they would be readily washed from the surface of the ware by the rain, as soon as they formed.

According to Gerlach, a clay containing 0.1% calcium sulphate, which is 0.4 gram per lb., would require 0.6 gram of barium carbonate to perform the reaction. However, 6 or 7 grams should be added to every pound of clay, for safety. This would mean practically 100 lbs. per 1,000 brick. If barium chloride is used, but 26 lbs. are required per 1,000 brick. However, when this is used, close to the theoretical amount must be added, for if added in excess it will form a scum itself.

This method cannot, of course, be used in the dry press process, where no water, or at least very little, is added, as the barium or other salts must be used in solution to do the required work.

TREATING THE WATER.—When it is necessary to use a water that contains injurious soluble salts, it is simply necessary to precipitate them before adding the water to the clay. Many good clays are being ruined by bad water, when it needs but a few hours of a chemist's time to rectify the trouble.

CORRECT DRYING.—If ware containing soluble salts is placed in a drier and allowed to sweat slowly, the chances are all in favor of scummed ware, whereas, if the water is carried away from the surface of the ware as fast as it appears this will not often be the case.

It is a remarkable physical fact, not yet fully explained, that where a clay contains soluble salts, they are not deposited on the surface at all, or at least to a less degree, where the drying is steady and rapid, than where it is slow and discontinuous. It seems that rapid drying causes the water to come through the pore channels of the clay as through a filter and a sort of osmosis is set up, by which the saline matters are retained inside the mass of clay, while the water escapes as vapor from the outside. But where the drying is slow the salts get through this barrier and arrive on the surface plentifully.

It is therefore only necessary that brickmakers, in order to avoid trouble from this source, build good driers and install in them hygrometers by which their operation can be controlled.

Many other methods are used to prevent this trouble; some of them, however, have but temporary effects. One of these is to paint the surface of the scummed ware with oil, which for the time being covers up the scum. This is really practicing a fraud, for while the ware does not show scum when put into the building it shows up as soon as the oil evaporates.

Another method is to paint one surface of the unburned brick with a heavy oil or tar. This prevents evaporation from that surface, the salts being carried to the other surfaces. The oil or tar is burned off in the kiln, leaving a clean face. This, too, is only temporary unless the brick is vitrified, as otherwise the salts will be drawn to the clean surface after a few soakings.

Ancient and Modern Bridges at Bethlehem, Pa.

By L. F. BELLINGER,* M. Am. Soc. C. E.

A railroad traveler passing through Bethlehem, Pa., on either the Philadelphia & Reading R. R. or the Lehigh Valley R. R., can scarcely help noticing from a viewpoint near the railroad depot an old wooden bridge and a new steel bridge, both spanning the Lehigh River about 200 ft. apart. The wooden bridge is covered with a roof but is open sided, showing the arches of the Burr truss, and is in such good condition generally, so far as concerns verticality of trusses, level ridge to roof, and lack of sag in floor, that interest is awakened at the first glance. Urgent inquiry from an engineer friend in Bethlehem developed the probability that the bridge antedated the "oldest inhabitant" and merely added to my desire for definite information about the old bridge and other interesting bridges in this city. One photograph (Fig. 1) taken from the river bank gives a near view of the old Burr truss and shows its generally excellent condition. Fig. 1 shows the new railroad bridge of steel built in 1908, replacing an iron railway bridge built in 1885, the new Broad St. bridge over Monocacy Creek in the background, consisting of reinforced-concrete arches, built in 1910, replacing a 30-year old iron viaduct, and the old wooden highway bridge which has outlived all the ancestors of the other bridges shown.

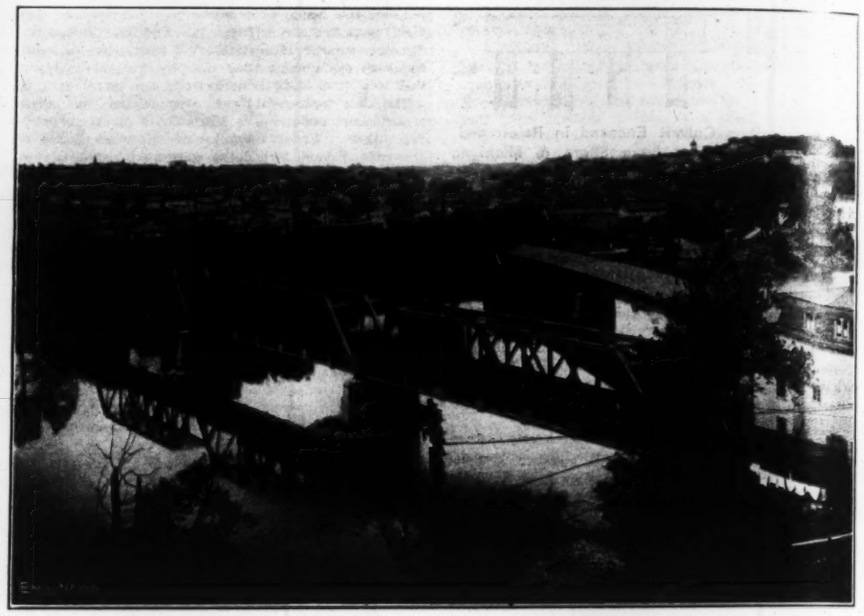


FIG. 1. THREE TYPES OF BRIDGES AT BETHLEHEM, PA.
(A 94-Year-Old-Burr truss in the right foreground, a modern steel truss in the left foreground and a series of concrete arches across the valley in the background.)

My informant, after consulting Levering's History of Bethelehem, Pa., states that the north span of the old timber bridge (the span seen on the farthest side of the river in the views) was built in 1816, which "will make the bridge 94 years old." The early history [illegible] there was a "good roads" agitation in [illegible] probable turnpike from Philadelphia [illegible] autumn of 1791, and on Jan. 2, 1792, [illegible] appointed a bridge committee consisting [illegible] Moravian Bishop, a tavernkeeper, [illegible] man, a teamster and a carpenter. [illegible] three opposed the bridge, but in the [illegible] the Bishop, the people voted almost unanimously for the bridge on Jan. 23, 1792. The Assembly authorized the bridge April 3, 1793. The bridge was begun May 12, 1794, and completed Sept. 27 in the same year under an engineer named Trucks, who built a plain wooden structure on piles at a cost of $7,800. It had no roof; neither had its successor, which was opened to traffic Oct. 19, 1816. This bridge rested on three piers. June 5, 1862, the breakage of dams caused the washing away of all but the north span. The two southern spans were rebuilt and covered with a slate roof. The bridge was a toll bridge for 100 years after it was projected, i. e., until Nov. 8, 1892. Then it was made free by the counties of Lehigh and Northampton, which paid for it $26,000.

The oldest wooden span on the far side of the river is 125 ft. in length; the middle span is 110 ft., and the southernmost span 135 ft. long. Other details and dimensions are as follows:

Width out to out of trusses	21.3 ft.
Clear width of roadway	18.2 ft.
Height of trusses	13.0 ft.

The trusses are put together with treenails and bolts. The heaviest load permitted at the present time is a heavy five-ton motor car with a

FIG. 2. NEAR VIEW OF THE OLD BURR BRIDGE AT BETHLEHEM, PA.
(The far truss was built in 1816, the nearer ones in 1862.)

*Civil Engineer, U. S. Navy; U. S. Navy Yard, Philadelphia, Pa.

heel base of 12 ft. 6 ins., carrying a total load to seven tons. Sidewalks were added in 1883 and widened since then. Repairs made are reported as very few.

Information received from various sources is somewhat conflicting. One history mentions three piers belonging to the bridge of 1794 and some in 1816. Another history mentions the bridge being washed away in the flood of January, 1841, leaving only "the four piers." The bridge is decidedly interesting, however, on account of its excellent condition, the few repairs made, the load carried, and especially on account of its neighbors, the riveted steel truss, and the reinforced-concrete arch, all showing clearly in the one photograph.

For a large amount of information and attention, I am indebted to Lieut. W. S. Brown, of the Bethlehem Steel Co.

Notes from Engineering Schools.

UNIVERSITY OF TEXAS.—A new power plant and heating station has just been finished in Austin at a cost, for building and equipment, of approximately $100,000. It is claimed to be one of the most complete and modern plants in any college in the country. It provides power for the several buildings about the University, and has in reserve sufficient capacity of electric generators to light the whole institution in case the municipal supply is cut off. The station also houses a steam laboratory and shops for training in wood and iron working.

The building is of brick and steel, with stone and concrete trimmings and a tile roof. The boiler room has two 200-HP. and one 100-HP. water-tube boilers, one of which is built for 250 lbs. working pressure and for superheating steam to 200° F. Two of the boilers are equipped with automatic stokers. The high-pressure steam is reduced, to pressures required for the heating lines, by reducing valves in the pump room. Here, also, are six vacuum and feed pumps, water heaters for the gymnasium, etc. There is a large receiver for holding condensed steam from the various buildings until the water is needed in the boiler room. Two tunnels, leading to the different buildings, are about 1,000 ft. long and contain about 10,000 ft. of piping. This plant furnishes live steam to the engineering, chemical and geological laboratories, in addition to that for heating.

The ashes fall into hoppers underneath the boiler furnace grates and are transferred to an iron car moving on a track underneath the boilers. On this track is a set of scales. From the scales the ashes are conveyed to a hydraulic hoist which lifts the car to the surface for unloading.

The steam-laboratory equipment comprises two steam turbines, a compound Corliss engine, a two-stage air compressor, a duplex pump and apparatus for testing injectors, inspirators, orifices, nozzles, indicators, gages, etc. One of the steam turbines is direct connected to a 75-KW. generator. A 75-HP. producer-gas engine will soon be installed in the laboratory. Condensers and condenser pumps for the power apparatus are located in the basement. The machine and woodworking tools in the shops are all driven by individual electric motors.

A COAL MINE EXPLOSION in a mine operated by the Yolande Coal & Coke Co. in Tuscaloosa Co., Ala., 30 miles south of Birmingham, killed five men Nov. 4.

TWO COAL MINE EXPLOSIONS have been reported, one in Washington and one in Colorado. An explosion in the Lawson Coal Mine at Black Diamond, Wash., Nov. 6, entombed 15 miners. The mine is reported to have been completely wrecked.

An explosion in Mine No. 3 of the Victor-American Fuel Co., at Delagua, Colo., 22 miles northwest of Trinidad, Nov. 8, entombed about 70 men.

A WORK CAR RAN AWAY ON A GRADE at Tualatin Hill on the tracks of the United Rys. Co. near Portland, Ore., Oct. 26. The car was uncoupled from its locomotive at the west portal of the tunnel through Tualatin Hill. The brakes failed to hold the car and it started down the slope. It is reported to have run half-a-mile in less than a minute and then collided with a flat car. Of the 35 persons on board the work car five were killed outright and 25 were seriously injured.

A WATERFRONT FIRE AT KEY WEST, FLA., Nov. 2 destroyed the Peninsula and Occidental steamship dock and warehouse, valued at $300,000.

ANOTHER CAVE-IN AT STAUNTON, VA., killed one of four men at work on the concrete arch which was being built over the chasm left by the cave-in of Aug. 11, 1910. An account of the first cave-in was published in Eng. News, Sept. 1, 1910.

THE BALLOON "AMERICA II.," which was noted in our issues of Oct. 20 and 27 as sailing from St. Louis on Oct. 17, in the annual International Balloon Race, was reported as landing on Oct. 19 in Chicoutimi Co., Quebec, Canada, 30 miles north of the town of Chicoutimi, on the Saguenay River, which is about 100 miles north of the city of Quebec. The air-line distance, computed from the latitudes and longitudes of start and finish, is somewhat under 1,200 miles, although the record as reported in the daily press was 1,355 miles. This gives the James Gordon Bennett International Cup to the crew of the "America II.," Messrs. A. R. Hawley and Augustus Post, and if the larger figure stands, also establishes a new record for distance traveled in a balloon, the best previous record being the long-standing one of Count de la Vaulx, made in 1900—1,193 miles from France to Siberia. The long delay in reporting was due to the difficulty of the aviators in getting to the railway.

RAILWAY ACCIDENTS in the United States during the months of April, May and June, 1910, are reported in accident bulletin No. 36 issued by the Interstate Commerce Commission. The number of persons killed in train accidents was 137, and of injured 2,641. Accidents of other kinds, including those to employees while at work bring the total for the quarter up to 766 killed and 19,884 injured.

The number of passengers killed during the quarter was 43, but only seven of these were killed in train accidents. As usual, a majority (23) were killed in getting on or off trains. The number of passengers injured in train accidents was 1,025 and the total passengers injured in all classes of accidents was 2,322.

This bulletin gives the total number of passengers and employees killed in the year ended June 30, 1910, as 3,804 and the number injured as 82,374. The number killed is the largest reported since 1907, when 5,000 were killed. In 1909 the number killed was 2,791. The number of injured in 1910 is the largest ever reported by many thousands. The injured in 1909 numbered only 63,920. In 1907, however, the number of injured was 76,286.

The number of collisions in the year 1910 was 5,801; derailments, 5,918. This is more than in 1909 when there were 4,411 collisions and 5,259 derailments; but in 1907 there were 8,026 collisions and 7,432 derailments. An unusual feature for the year 1910 was that the number of collisions so nearly equalled the number of derailments.

BOILER ELEVATOR AND FLY-WHEEL accidents in the United States and Canada for the month of Sept. 7 to Oct. 6 are listed by the Fidelity & Casualty Co., of New York City. The number of boiler accidents reported was eleven. Two of these each killed two persons and six other explosions each killed one person.

The number of elevator accidents listed is 88, and of these, 14 each killed one person. Of the fatal accidents, four were due to persons falling down the shaft, in six the victim was caught between the car and the building and in two the elevator fell.

A VERY LARGE PUMPING ENGINE has recently been built for the city of Wheeling, W. Va. It is stated by the builders, the Allis-Chalmers Co., of Milwaukee, Wis., that this engine is practically equal in power to the one at Nashville, Tenn., which they claim is the largest ever built. The engine at Wheeling is of the vertical, triple-expansion, flywheel type with steam cylinders 42 ins., 74 ins. and 110 ins. in diameter by 72-in. stroke. The low-pressure cylinder, according to the builders, is the largest ever used on a pumping engine. The engine is designed for a steam pressure of 125 lbs. per sq. in. and a vacuum of 27 ins. of mercury. At the normal speed of 18½ r. p. m., the piston speed will be 220 ft. per min. The pit in which the water end is located is 46 ft. deep and the total height of the engine from base of water end to top of steam end is 84 ft. 8 ins.

The admission valves of the high-pressure and intermediate cylinder and exhaust valve of the high-pressure cylinder are of the Corliss type. Poppet valves are used for the intermediate exhaust and for both admission and exhaust on the low-pressure cylinder. The steam from the jackets of the high-pressure and intermediate cylinders is trapped into the second receiver and does useful work in the low-pressure cylinder. The surface condenser is located in a by-pass on the discharge line. The condenser pump is driven from an arm on the low-pressure plunger.

The pistons have single piston rods which are screwed into cast-steel cross-heads and secured by lock nuts. The steam cross-heads are connected to the water cross-heads each by four distance rods. Two flywheels are provided, each weighing 90,000 lbs. The diameter of the water plungers is 33 ins. The valve chambers are of cast-steel and are 78 ins. in diameter—the largest ever built, according to the builders. The 186 valves in each chamber are placed directly in the steel valve deck without cages. The valves are of a special gravity type without springs.

THE DESIRABILITY OF GRANTING RIGHT OF eminent domain to electricity supply and transmission companies is being studied by the Massachusetts Gas and Electric Light Commission. The work of these companies in Massachusetts, as in general in communities well settled, has tended toward a wholesale business, the energy being sold in large blocks by the generating company to local supply companies and to large commercial establishments. The proposed scheme permits granting a certificate of exigency under which the transmission line may be built. Under this certificate, the municipal authorities would retain the right to specify the location and construction along the route under their respective jurisdictions. It is also proposed that the routes shall not be laid along any public way without the consent of local authorities. The rights of eminent domain are to be bestowed in cases where the exercise of such right seems necessary for the most economical construction of the line. An interesting point of the constitutionality of such a bill, if made a law, has arisen at the hearings. The objection has been made that the right of eminent domain cannot be granted to persons or corporations not directly concerned with the public use of the service for which the condemnation is made, as in the case when electrical energy is transmitted for sale to a local distributing company. This point, however, does not hold in granting such a right of eminent domain to true distributing companies, where the company enjoying it directly serves the public.

THE PRODUCTION OF LUMBER IN THE UNITED States during the calendar year 1909 was 44,585 million feet, board measure. This is an increase over the production of 1908 of 34.2% and over that of 1907 of 10.8%. This information appears in a preliminary comparative report covering these three years, which the U. S. Bureau of the Census has issued. The substantial increase over the two previous years was general, few of the states showing any decrease in cut.

Yellow pine, including the several species longleaf shortleaf, loblolly, Cuban, etc., still constitutes nearly three-fourths of the total cut of the southern states from Virginia to Texas. The total cut of these states is about half of the total production for the entire country, having increased from 44.3% in 1907 to 49.5% in 1909. The yield of New York and New England has decreased from 9% in 1907 and 9.6% in 1908 to 7.5% in 1909, of the total cut for the whole country.

The lumber production of the three Lake states, Minnesota, Michigan and Wisconsin, once greatest of all lumber regions, is steadily declining. The yield of these states in 1907 was 13.6% of the total and in 1909, 12.3%. The Pacific coast states, with an output 28.3% larger in 1909 than in 1908 and 2.2% greater than 1907, nevertheless contributed a smaller proportion of the total cut of the country in 1909 than in either of the preceding years. Douglas fir constitutes about 68% of the yield of these states.

THE IMPROVEMENT OF THE WATER-SUPPLY OF Ottawa, Ont., either by filtration of the present supply from the Ottawa River, with a continuation of pumping, or else by introducing a new supply from McGregor Lake, by gravity, has been reported on by Mr. Allen Hazen, M. Am. Soc. C. E., of New York City. The first cost of a filtered supply would be less than that of the first installment of gravity works of like capacity, but the gravity works would be readily capable of enlargement and on capitalizing operating expenses in each case there would be little difference in the total cost of a filtered supply from the Ottawa River and a gravity supply from McGregor Lake. Water from the Lake would be better than that from the river, and Mr. Hazen recommends the lake source, provided the necessary authority to build works in the Quebec can be obtained. The gravity supply would require a dam, about 12½ miles of 54 and 60-in. steel pipe, and crossings of the Ottawa and Rideau rivers. The estimated first cost of works capable of bringing 30,000,000 Imp. gals. per day from McGregor Lake, and of delivering an average of 20,000,000 Imp. gals. per day, would be about $2,300,000. The annual operating charge would be $5,000, and this capitalized at 5% would be $100,000, thus bringing the total cost up to $2,400,000. For purification works of like capacity to the gravity works, with necessary pumping plant and accessories, the first cost would be $1,279,000. The operating cost would

be $41,000 per year for the filters and $11,000 for the pumps, or $52,000 in all. Capitalizing this total at 5% would give $1,040,000, and this added to first cost would give $2,319,000. But a large part of the expenditure for the filter plant would be postponed for a number of years. A mechanical filtration plant, using sulphate of alumina as a coagulant, supplemented by the use of hypochlorite of soda is the basis of the filtration estimates.

THE QUEBEC BRIDGE.—Mr. H. E. Vautelet, Mr. Modjeski and Mr. MacDonald, composing the Board of Engineers of the Quebec Bridge, were in this city to-day when an official meeting of the board was held. The engineers visited the drydock at Levis, where they examined the caisson which was brought there recently from the site of the bridge at Cap Rouge for repairs. After a minute investigation into the damage which the caisson had suffered, and for which it was floated, the engineers decided to meet again on Nov. 23, and in the meantime a careful study of the caisson will be made from notes which they took and which will enable them to give their decision when they meet again.

It was stated that the damage to the caisson was of little importance and would not retard the building of the bridge. The actual work of erecting the ironwork of the bridge would be begun in the fall of 1911, Mr. Vautelet said, and everything was going on splendidly at the present time. The work of removing the tangled steel of the fallen bridge was nearly completed, 7,000 tons having already been cleared away, and the cribwork preparatory to laying the caissons was now under construction. . . . Mr. Vautelet stated that according to contract the bridge would be completed between 1914 and 1915. [Quebec dispatch to Montreal "Gazette," Nov. 1, 1910.]

THE RIM WEAR OF ROAD ROLLERS is given by Mr. L. Crouch, in the "Engineering Review," October, 1910, as ½-in. to ⅝-in. per year on the hind wheels and ¼-in. to 5/16-in. per year on the front wheels. The wear on the rear wheels, on which comes the whole driving torque (and most of the weight) is about twice that on the front wheels. Mr. Crouch estimates that in average service the wheels themselves (hub and spokes) will last 20 to 30 years, but that new rear rims will be required every 3 to 5 years, and new front rims every 6 to 10 years, depending on the nature of the work and the number of hours worked per year.

FREEING CONDENSED WATER FROM OIL by electricity is described in a paper by Mr. R. Ellis before the Society of Chemical Industry (British) and printed in the journal of that society for Aug. 15. It is stated here that the ordinary baffle-plate separator removes only about 75% of the oil and steam, 25% passing out as a dilute emulsion. The minute globules of oil thus formed, it has been found, cannot be completely separated by flotation, as the emulsion has been kept for months without separation. A type of oil separator, known as the Davis-Perrett, has been devised, having its action dependent on the formation, by electrolysis, of a hydrate or carbonate of iron which, being flocculent, in settling carries down with it the minute particles of oil. Iron electrodes are employed with sodium carbonate as the electrolyte. It is claimed that this apparatus gives an efficiency of removal of 98.5%, compared with 95 and 96% for filters. The operating costs are stated to be about 30 cts. per 1,000,000 gals. of water treated. The apparatus requires no attention other than the addition of the sodium carbonate solution from time to time, a self-flushing filter being a part of the apparatus to remove the precipitate as it settles.

Personals.

Mr. Kenneth Seaver has been appointed Chief Engineer of the Harbison-Walker Refractories Co., of Pittsburg, Pa.

Mr. J. E. Noeggerath, Assoc. Am. Inst. E. E., formerly of the General Electric Co., has opened an office in New York City as consulting engineer.

Mr. Thomas R. Taltavall, Assoc. Am. Inst. E. E., for the last 14 years Associate Editor of the "Electrical World," has resigned to become Editor of the "Telegraph and Telephone Age."

Mr. W. L. Upson, Assoc. Am. Inst. E. E., has resigned as Assistant Professor of Electrical Engineering at Ohio State University to become Professor of Electrical Engineering at the University of Vermont.

Mr. Charles I. Corp, Jun. M. Am. Soc. M. E., Assistant Professor of Mechanical Engineering at the University of Kansas, has been granted a year's leave of absence to engage in special hydraulic researches at the University of Wisconsin.

Mr. Albert Gray Norton, M. Am. Soc. C. E., formerly Resident Engineer of the Erie R. R. at Otisville, N. Y., has opened an office in Middletown, N. Y., for the purpose of carrying on a general practice in engineering and architecture.

Mr. W. H. Dooley, formerly Master Mechanic of the Queen & Crescent Route, C. N. O. & T. P. Ry., at Birmingham, Ala., has been appointed Superintendent of Motive Power, succeeding Mr. J. P. McCuen who resigned on account of ill health.

Mr. Arthur H. Blanchard, M. Am. Soc. C. E., Associate Professor of Civil Engineering at Brown University, and Deputy Engineer of the State Board of Public Roads of Rhode Island, has established a general consulting practice in highway engineering at Providence, R. I.

Councilor Loewer and Herr Feddersen, of the Elbe River Regulation Commission of Germany, are visiting the United States for the purpose of inspecting river and harbor improvements and waterway regulation. They are at present examining the work of the New York Barge Canal.

Mr. Octave Chanute, M. Am. Soc. C. E., who suffered a serious attack of pneumonia while in Europe last summer, is now at his home in Chicago. He is still in a very weak condition. The Aeronautical Society of Great Britain has made him an Honorary Member and has presented him with a gold medal in recognition of his distinguished services in the development of aviation.

Mr. George E. P. Smith, Assoc. M. Am. Soc. C. E., Irrigation Engineer at the Agricultural Experiment Station at the University of Arizona, is taking a year's leave of absence to make investigations in irrigation and hydraulic engineering at the University of Wisconsin. Mr. Smith is a graduate of the University of Vermont of the class of 1897 and was formerly Professor of Civil Engineering at the University of Arizona.

Capt. Robert E. Peary, whose leave of absence from his duties as an engineer officer in the Navy Department has just expired, will be assigned to duty as Engineering Expert for the Department of Justice. He will serve in an advisory capacity in the settling of a number of claims upon the government for work done for the Navy Department on dry-docks and similar structures. Capt. Peary's leave of absence had extended over ten years, during which time he has been engaged in arctic explorations.

Mr. John A. Bensel, President of the American Society of Civil Engineers, has been elected State Engineer of New York on the Democratic ticket, succeeding Mr. Frank M. Williams, Republican. Mr. Bensel is at present President of the Board of Water Supply of the City of New York. He is a graduate of Stevens Institute of Technology, class of 1884. (A biographical sketch and portrait of Mr. Bensel were published in Engineering News of Jan. 20, 1910.)

Messrs. Leonard Metcalf, of Boston, Mass.; John W. Alvord, of Chicago, Ill., and George G. Earl, of New Orleans, La., all members of the American Society of Civil Engineers and specialists in water supply, have been selected as arbiters to settle a controversy between the city of Macon, Ga., and the Macon Gas Light & Water Co., relative to the purchase of the plant of the water company by the municipality. The board will meet on Nov. 21. These three engineers were picked from a selected list of six, which was submitted to the city authorities, by Messrs. Caldwell and Hazelhurst, who furnished estimates on the water-works plant to the old city administration. The selection was made by an arbitration board of four, two representing the city and two the water company.

Obituary.

Arthur Keddie MacFarlane, Jun. M. Am. Soc. C. E., Chief Engineer of the Benicia Iron Works at Benicia, Cal., was accidentally killed on Nov. 2, by contact with a live electric wire, while engaged in directing the work on an extension to the plant. Mr. MacFarlane was a graduate of the University of California, and although but 23 years of age, had shown marked engineering ability.

Sir James Clifton Robinson, M. Inst. E. E., of Great Britain, died on Nov. 6 in a drug store in New York City from heart disease, after being stricken in a street car. He was 62 years old and one of the most famous street railway experts of England. He had been a member of the staff of the late George Francis Train. He was connected with the installation of street railways in Los Angeles, Cal.; Dublin, Ireland; London, England, and many other places. He was until recently Managing Director and Engineer of the London United Electric Tramways, and also Chief Engineer and director of the electric railways of Bristol, Dublin and other cities. He visited practically all the larger cities of this country and Canada. He was the author of many papers on electric railway engineering and an Associate of the Institution of Civil Engineers. He is said to have been an advocate of municipal ownership of street railways.

William Henry Brewer, Professor Emeritus of Agriculture at Sheffield Scientific School, Yale University, died at his home in New Haven, Conn., on Nov. 2. Prof. Brewer was born in Poughkeepsie, N. Y., on Sept. 14, 1828. He held degrees from the famous universities of Yale, Heidelburg, Munich, Paris and Washington and Jefferson. He was Professor of Chemistry and Geology at Washington College, Pa., 1858-'60; First Assistant on the Geological Survey of California, 1860-'64; Professor of Chemistry at the University of California, 1863-'64, and Professor of Agriculture at Yale University from 1864 to 1903, when he retired as Professor Emeritus.

Prof. Brewer was a member of the Society for the Promotion of Agricultural Science, the National Academy of Sciences, and a member and former President of the Arctic Club of America. He served at various times on numerous government and state commissions, was President of the Connecticut State Board of [illegible] from 1892 to 1909.

Engineering Societies.

COMING MEETINGS.

NATIONAL MUNICIPAL LEAGUE.
Nov. 14-18. Annual meeting at Buffalo, N. Y. Secy., C. R. Woodruff, North American Bldg., Philadelphia, Pa.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 15. Annual meeting at Washington, D. C. Secy., Wm. H. Connelly, Interstate Commerce Commission, Washington, D. C.

AMERICAN RAILWAY ASSOCIATION.
Nov. 16. Semi-annual meeting at St. Louis, Mo. Secy., W. F. Allen, 24 Park Pl., New York City.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 17-18. Annual meeting at New York City. Secy., W. J. Baxter, 29 West 39th St., New York City.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Nov. 17-19. Annual convention at Boston, Mass. Secy., James C. Monaghan, 20 West 44th St., New York City.

NEW JERSEY SANITARY ASSOCIATION.
Dec. 2-3. Annual meeting at Lakewood, N. J. Secy., J. A. Exton, 75 Beech St., Arlington, N. J.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 5-6. Annual meeting at New York City. Secy., W. H. Ross, 154 Nassau St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 6-9. Annual meeting at New York City. Secy., C. W. Rice, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 7-9. Annual meeting at New York City. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 12-14. Annual convention at New York City. Secy., Percy H. Wilson, Land Title Bldg., Philadelphia, Pa.

NATIONAL ASSOCIATION OF CEMENT USERS.
Dec. 12-23. Annual convention at New York City. President, Richard L. Humphrey, Harrison Bldg., Philadelphia.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 27. Annual meeting at St. Paul, Minn. Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 27-28. Annual meeting at Lafayette, Ind. Secy., E. W. Hamilton, Iowa State College, Ames, Iowa.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 2-6. Annual meeting at Winnipeg, Man. Secy., C. H. McLeod, 413 Dorchester St., West Montreal, Que.

INDIANA ENGINEERING SOCIETY.
Jan. 12-14. Annual meeting at Indianapolis, Ind. Secy., Charles Brossmann, Indianapolis, Ind.

MONTANA SOCIETY OF ENGINEERS.
Jan. 12-14. Annual meeting at Helena, Mont. Secy., Clinton H. Moore, Leyson Block, Butte, Mont.

NATIONAL ELECTRIC LIGHT ASSOCIATION.—The exhibition committee is circulating a letter to the Class D. members recommending that the customary exhibit be omitted at next year's annual convention. This is because New York City is being seriously considered as the place for the next convention, and difficulty has been encountered in finding satisfactory facilities for the convention and exhibition under the same roof.

SAN FRANCISCO ASSOCIATION OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.—The 33d regular meeting was held at the Palace Hotel Oct. 21. About 90 persons were present. Mr. N. B. Kellogg was chosen as a candidate for membership on the nominating committee of the American Society of Civil Engineers to represent the western district. The paper of the evening was presented by Mr. James H. Wise, Assoc. M. Am. Soc. C. E., who gave a detailed description of the construction of the Lake Arthur earth dam in Placer Co., California. A Fitzgerald tamping road roller (described in Eng. News, April 4, 1907, p. 366) was used in compacting the fill, and 4,000 cu. yds. per week were dumped, spread and tamped. Nine patent dump wagons filled by scrapers, a road machine for leveling and one 6,800-lb. roller were used in this work.

WESTERN SOCIETY OF ENGINEERS.—At the regular meeting held at the Society's rooms in Chicago on Nov. 2, the proposed amended form of the constitution was discussed at some length, and this will now be submitted to letter ballot.

On motion of Mr. E. E. R. Tratman (Engineering News) a committee was appointed to prepare and present to Mr. Octave Chanute a letter of condolence on account of his recent serious illness; also expressing the hope of the society for his early restoration to health and strength, and congratulating him upon the award of the gold medal of the Aeronautical Society of Great Britain in recognition of his distinguished services in the development of aviation. Mr. Bement, who occupied the chair, appointed as members of this committee Mr. E. E. R. Tratman (Chairman), Mr. John W. Alvord (President of the Society), Mr. Onward Bates and Mr. C. L. Strobel. Mr. Chanute has been a member of the society since 1869, and was elected an Honorary Member in 1909. He was President of the society in 1901.